Fall 10-1-2018

Teachers Learning to Teach: A Phenomenological Exploration of the Lived Experience of Cognitive Load for Novice Teachers

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Dissertation submitted to the Faculty of the College of Education

in partial fulfillment of the requirements for the degree of

Doctor of Education in

Teacher Leadership

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Concordia University–Portland

2018

Abstract

Cognitive load is a relevant phenomenon experienced by novice teachers moment-to-moment in complex classroom environments. Teachers learning to teach within the classroom daily encounter mental workload, but the latter has played little part in learning design for teachers, although other professions demanding complex performanes have made use of Cognitive Load Theory and Cognitive Task Analysis for learning design and for the reduction of cognitive load. Exploration of the lived experience of cognitive load was the focus of this study. The purpose of this phenomenological study was to describe the limits of mental capacity and the mental liberty experienced by teachers who undergo different levels and types of cognitive load. The researcher exposed the multiple directions of awareness that result from looking at learning to teach through this lens, how teachers perceive the availability and immediacy of mental resources, and reconstruct lived experiences in the moment of classroom teaching. The consequenes of cognitive load, the resulting experiences from having undergone it, are explored as automaticity and higher levels of load reveal various levels and types of learning. New directions of learning design for teachers based on expertise transfer and complex learning models are proposed.

Keywords: cognitive load theory, cognitive load, teacher education, learning design, cognitive task analysis, teacher expertise transfer

Dedication

It is with gratitude that I dedicate this achievement to my wife, Marcia. She is my best teacher and friend, and her constant sacrifice and support for me made this possible. She helped me to persevere, and I wanted to make her proud. I also dedicate this to my father-in-law, Al Mills, who spent his last years with us at the time of this research and constantly encouraged me. Lastly, I dedicate this to my grandchildren, who sacrificed Grampy-time. I thank you and I love you.

Acknowledgements

Thanks to my Concordia University–Portland teachers for much that they imparted to me.

Thank you to my family of teachers, my father, Larry, my brother, Greg and my sister-in-law, Nancy. Thank you, again, Marcia, my beloved wife. I have always been so proud to belong to a family dedicated to educating students and for your influence on me. Thank you to all the teachers who have worked with me and inspired me through my years as a principal, and who taught me through their classroom teaching, especially Richard Stodola.

Thank you to the district representatives who supported this research. Lastly, and most importantly, thank you to the novice teachers who consented to participate in this research. They are to be commended for helping to advance research of cognitive load, and without their generous time and work this dissertation could not have been written.

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Chapter 1: Introduction

Imagine a teacher trainer working in the classroom with novice teachers. She wants to make them successful, and is confident she fully understands her own success. She was made a coach and mentor due to her own demonstrated classroom expertise, and since she is a seasoned teacher, feels development of novice teachers should be easy. She simply has to get them to do what she is currently doing, the things she knows are important. She has reviewed the literature of what makes a good teacher, the rubrics for particular domains of teaching such as Danielson's Framework (Danielson, 2013) and the Measures of Effective Teaching (Kane, Kerr, & Pianta, 2014). These measures offer standards and signposts for effective performance, reflect her own results, and she feels she can measure novice performance against these. During her attempts to facilitate teacher professional development, the trainer observes the practice and problem-solving of novice teachers as they attempt to perform according to these standards. She notes the results, and attempts to engage novice teachers in meaningful reflection on their practice, and she shares with novices the strategies that currently make her own classes effective.

However, the novice teachers still have problems navigating the classroom. She notices the rookie teachers struggling to keep students engaged, that classroom disruptions occur and interrupt the execution of her prescribed innovative techniques, that the need for student redirections increases, and novice teachers are overwhelmed as seemingly mundane interactions between students and teachers unfold. When in stressful situations, the novices default to ineffective techniques, miss cues from classroom happenings, and fail to perform strategies she herself finds very natural and obvious when diverted by classroom problems. As she leads novices in professional conversations the focus continually drifts back to frustrations, to being overwhelmed by the amount of problems to solve in specific moments. The teachers do not respond well to problems she considers ordinary and natural with solutions she herself would call mundane. While novice teachers may feel overwhelmed and express their experience of frustration, this information seems irrelevant for her task of promoting expert practice (e.g., teaching high leverage expert practices she herself is still working to refine). For this teacher-coach, feeling overwhelmed in the first years of classroom teaching is simply a reality of novice induction, and she encourages trainees to push through it. Learning to teach, she understands, is about time and experience, trial and error as one interacts within the classroom. She expresses empathy with them, but the limits of these novice teachers' skills at processing information and problem-solving should not, for this coach, impact the way she communicates the *what* and the *how* of good teaching.

What is missing in this scenario is a sense of wonder at what new teachers hope to do, awe in the face of the novice teacher's struggle to acquire what could be called "the magic" of expert teaching. The expert coach usually navigates the classroom with ease, draws from well-developed memory schemas accurate solution moves, and performs gestures, analyses, and responses automatically, without conscious effort (Kalyuga, 2010); there may be little wonder or awe in the expert teacher over what have become obvious tasks within their natural environment. Wonder creates a *dis-position*, a sense of dislocation and displacement before an experience that allows questioning (van Manen, 2014). For this coach, it seems counterproductive to wonder at frustration or at being overwhelmed. However, teachers acquire expertise in the vast complexity that is a classroom, where information comes from dozens of learners at once, constantly, with challenges that demand a clear flow of interpretations and responses in order to meet shifting goals. The new teacher must move many eager and unruly minds forward, together, through enacting a multiplicity of complex techniques, often simultaneously, including precise physical gestures, shifts in tone, gentle redirections, and all the while must communicate care, new information, and focused praise while also diagnosing thirty ways of thinking and levels of motivation. A state of awe and wonder should accompany the endeavor to acquire teacher expertise, at what must happen within the novice teacher, the mental processes and skills being built up from daily experience. At the heart of the novice struggle to acquire expertise there remains an unsuspected enigma, often dismissed, a phenomenon that, once seen and understood, may reveal on familiar maps of novice teacher instruction unfamiliar and new territories for teacher induction. Experiences of novice *frustration*, their *being-overwhelmed* are signposts to this phenomenon, what a particular branch of cognitive psychology calls *cognitive load*.

For cognitive psychologists, cognitive load is not only relevant, but also decisive to the process of acquiring expertise in complex environments (Vogel-Walcutt, Gebrim, Bowers, Carper, & Nicholson, 2011). Teachers learn authentic, whole tasks within their complex environment, but task complexity in such learning can be overwhelming. Cognitive load (CL) may be defined as an aggregate of mental effort in working memory, the amount of non-automated processes that are needed to solve a problem (Salomon, 1984). Cognitive Load Theory (CLT) deals with the limited processing capacity of the human mind (van Merriënboer & Kirschner, 2013). For CLT, meaningful learning and efficient instruction can only be designed while keeping the levels and types of mental workload experienced by novices as a primary and critical focus. (Kalyuga, 2010; Sweller, 2010a). From CLT's perspective, all learning is acquisition and automation of long-term memory schematic knowledge and this building of schemas in long-term memory is dependent on the interaction of learning elements in a limited working memory (Sweller, 2010a). The levels of teacher cognitive resources dramatically effect the optimal transfer of expertise, whether in instruction, mentoring or preservice apprenticeship. Novices who experience frustration and being overwhelmed as they strive to solve problems or integrate new skills into their practice are undergoing what CLT theorists commonly call “limitations in working memory” or “lack of available cognitive resources” or “extraneous cognitive load” (Feldon, 2007a; Kalyuga, 2010). Although these latter concepts play little formal role in teacher education, CLT considers them critical factors in all designs of expertise transfer (Feldon, 2007a; van Merriënboer & Kirschner, 2013).

A learning design may be may be defined as a plan for potential activities with learners; it would integrate theories, research, models of human learning, including the goals of learning, characteristics of learning, magnitudes of change and environment in order to affect quality and effectiveness (Dalziel, et.al., 2016). For the researcher, the omission of CL from novice teacher learning design is a deficiency in current teacher education. The central problem of this research is the depthful exploration of the experience of CL from the subjective accounts of novice teachers. This study explores the phenomenon of CL in the lived experience of novice teachers in depth. It represents a shift from a specific learning theory within cognitive psychology to the rich descriptions novice teachers offer from their lives, a movement from theorists’ ways of explaining specific successes or failures in expertise transfer, to descriptions of what teachers engaged in learning undergo in the complex classroom. A depthful insight is the goal of all phenomenological research, and this research is oriented to exploring lived descriptions of CL, those parts of the experience that make it resistant to fuller understanding, and the meanings applied that gives the phenomenon its depth (van Manen, 2014). According to van Manen (2014), the principle and condition necessary for phenomenology is wonder, and this research considers the learning struggles of new teachers as having a full and enigmatic essence demanding study. This research utilizes phenomenology to develop new paths to this complex phenomenon for the sake of improving new teacher learning design and problem-solving.

Background to the Problem and Conceptual Framework

The issues of phenomenological study of CL elaborated in this introduction are three. First, although CL has played little part in the way most trainers design teacher learning, the phenomenon is decisive and relevant to all expertise transfer and problem-solvingproblem-solving. Learning and problem-solvingproblem-solving occur first and primarily in a teacher's mind, and quality psychological processes are not only pertinent, but may be the entirety of teacher learning when it comes to transfer of expertise; the phenomenon is decisive for CLT in identifying ways to optimize and enhance expertise transfer, although it is absent from most teacher education literature. A second issue is that the phenomenon CL is resistant to fuller understanding, especially as experienced and studied in the complex classroom environment by novice teachers. The multidimensional nature of the psychological construct, the complexity of the tasks of teaching and classroom environment complexity account for most resistance. Cognitive psychologists also locate such resistance within expertise itself. Experts' well-developed schemas eliminate CL from their experience of the most basic tasks that comprise their performance. Experts are unconscious of their own automated practices, and this can account for a lack of awareness of novice CL. This can lead to flawed learning design and a lack of perception of the relevancy of novice mental workload. Third, phenomenological in-depth interviews, facilitating observations and coding of rich descriptions offer a unique and fundamental path to the phenomenon CL. Given the relevancy and resistance to understanding of the phenomenon of CL, education research must turn to novice teacher experiences and honor their voices.

The Phenomenon Cognitive Load is Relevant to Teacher Expertise Transfer and Problem-Solving

In the learning taxonomy of cognitive psychologists, *expertise* refers to a domain and task specific set of exceptionally performed skills. *Transfer* is indistinguishable from learning as the degree to which the performance of a task affects another performance of the same task (Kimball & Holyoak, 2000). Cognitive psychologists speak of *expertise transfer* when describing complex learning (van Merriënboer, & Kirschner, 2013), although their language and focus is mostly absent from literature and research on teacher education. When Darling-Hammond (2006) summarized educators' extensive research of the problems of teacher learning and the development of a knowledge base, she did not refer to a process of expertise transfer, only that teachers must learn to see teaching differently from their experience as students, need to enact the wide variety of teaching tasks, some simultaneously, and must deal with the complexity of the classroom, the academic and social goals found there. Education experts who design teacher learning do not see learning to teach as a transfer of domain-specific skills, but may expect teachers to develop within the culture of abandonment that Green (2014) described. For cognitive psychology, with its different taxonomy and contextual focus on the domain and task specific performance of experts, the fundamental problem that faces school leaders and teacher educators is expertise transfer (Lemov, 2016). There are expert teachers who can perform well, and novice teachers who struggle, and schools should strive to impact the performance of the novices with domain and task-specific skills; complex cognitive skills and professional competencies must be transferred to complex, real-world classroom settings and any design approach must support optimal transmission of skill and expertise (van Merriënboer, & Kirschner, 2013). When a novice teacher is placed in the classroom, that complex and rich environment becomes a place of real problem-solving and learning and, one may hope, of transfer of expertise; but simple placement will not make an expert (Green, 2014).

Teaching is a complex cognitive skill amenable to analysis in a manner similar to other skills described by cognitive psychology (Leinhardt & Greeno, 1986). CLT explains the psychological and behavioral phenomena that result from instruction and problem-solving. Psychological theories in general explain the relationships between psychological constructs, events in cognition, and observable phenomenon. CLT's main constructs are *cognitive load* and *learning* as it may happen in problem-solving. The theory is meant to explain the effects of variable instructional designs on these two constructs; in other words, the where and the how and the what of instructional practices creates outcomes that are explained by cognitive load theory (Moreno & Park, 2010). Cognitive psychology proposes a cognitive architecture in which every person has both a *long-term memory*, which has a virtually unlimited capacity, and a *working memory*, which holds a few items for limited periods. Teachers who are able to draw more from long-term memory demonstrate *automaticity*, a very low level of CL, or mental effort; they are able to meet the challenges of the multidimensional classroom, seemingly without a lot of thought, as they interpret, evaluate and respond to classroom events with low levels of CL (Blessing & Anderson, 1996; Carter, Sabers, Cushing, Pennegar, & Berliner, 1985; Sabers, Cushing, & Berliner, 1991). This may be why what expert teachers do seems like magic, or why they are described as natural-born teachers, when, in reality, they are not (Ericsson, & Pool, 2016; Green, 2014). Novice teachers with little long-term memory resources experience higher, sometimes overwhelming levels of CL, and this is a hindrance to acquiring problem-solving skills (Borko & Livingston, 1989; Borko & Putnam, 1996). When CL becomes too high, teachers are unable to efficiently learn from their experiences or effectively teach, and the levels of CL impact teacher effectiveness, happiness, and the ability of teachers to learn (Feldon, 2007a). Mental workload in the most basic, endemic tasks of teaching affects whether teachers are able to carry out the more powerful and expert initiatives while still managing classrooms, whether their creative resources are bound or freed (Lemov, Woolway, & Yezzi, 2012). The novice teacher, coming into the profession after admiring their favorite expert teacher, may leave the profession because of the failure of expertise transfer due to higher levels of CL, without ever understanding their own cognitive architecture or that their failures might have been the result of poor learning design.

David Feldon (2007a) provided the most comprehensive review of research on CL as it manifests in the domain of classroom teaching, and, as a cognitive psychologist, described the phenomenon. CL may be defined as an aggregate of mental effort in working memory, the amount of non-automated processes that are needed to solve a problem (Salomon, 1984). As problem-solving skills approach automaticity and become easier to do, their processes demand less CL (Anderson, 1995). As the schemas within long-term memory increase in complexity and *chunk* more steps of a process into single items, these learned processes occupy less space in working memory (Sweller, 1988). Novice teachers who try to solve problems will usually endure increased CL because of deficiencies in experience and undeveloped schemas needed for efficient processing. Those with more experience perform the same activities, with equal results, with less effort (Camp, Paas, Rikers, & van Merriënboer, 2001). Experts in many different domains exhibit that low levels of CL are required for skilled performances in relation to novices, even in the face of additional load being applied simultaneously in the form of other tasks (Allen, McGeorge, Pearson, & Milne, 2004; Beilock, Wierenga, & Carr, 2002; Rowe & McKenna, 2001). CL does not simply block learning, but different types of load on working memory enhance schema-building and automaticity. Such automated knowledge, a goal of expertise transfer, imposes little demand on working memory and allows experts to allocate their resources to more problems and immediate tasks. (Feldon, 2007a)

What CL theorists claim is that this phenomenon, an internal fact influencing the quality of all expertise transfer, is relevant to the design of professional development. Expert teachers can be made and their teaching become more effortless with attention to CL. CLT describes how working memory may become overloaded while processing information and how this impedes transfer of skilled processes to long-term memory. Early identification of CL is described by Moreno and Park (2010) as having the following assumptions. First, skilled performance depends upon schema acquisition. Second, for schema acquisition to take place, learning designers must attend to the problem states and the real solutions associated with specific techniques. Third, when learners attend to schema acquisition, learning is enhanced. Finally, learning designers must evade burdening the learner with CL, a primary inhibitor of learning, by limiting cognitive activities. (Cooper & Sweller, 1987; Sweller, Chandler, Tierney, & Cooper, 1990; Sweller & Cooper, 1985)

To meet these goals, cognitive psychologists have developed cognitive task analysis (CTA) (Hoffman, & Militello, 2014). The goal of CTA is to elicit expert knowledge and create learning designs that focus on building long-term memory schemas, constructs that store and order knowledge. CTA designs learning systems that chunk many elements or groups of learned tasks into single elements with specific functions. Once schemas are built in long-term memory, the working memory can draw them out as a single object or unit and use them with little effort, and such usage may be characterized as automatic. Novices, on the other hand, must go step-by-step through the exact same task. The expert can glance up, make a decision, communicate and interact with students in one seamless event, while the novice must think about each step of noticing, present and decide among different solutions and then perform several acts to solve an issue. The expert can do this unconsciously, while the novice must be conscious of each new and unfamiliar step. Expert performance happens because increasing amounts of complex schemas are integrated, and these schemas allow certain tasks to occur automatically and make limitations in working memory disappear. (Paas & Ayres, 2014)

In the area of instructional design, CLT has become one of the most influential theories in the area of complex learning (Ozcinar, 2009). CLT has been a proven framework for expert development in professions other than teaching, including medical and health professions (Quio et al., 2014; van Merriënboer & Sweller 2010). In aerospace (Jipp, 2016), the military (Vogel-Walcutt, Gebrim, Bowers, Carper, Nicholson, 2011), and other professions, CLT is accepted generally as a tool for expertise development (Paas & Kester, 2006; Remy, Rikers, van Gerven, & Schmidt, 2004). However, teacher preparation programs rarely use findings of cognitive psychology, CLT, dual-process models of thinking or learning processes with automaticity as a goal (Feldon, 2007a).

Complex learning designs utilize rich learning tasks within authentic living or professional situations, allowing learners to combine understandings, skills and feelings; because such tasks are the basis for complex learning, they allow learners to build the kind of expertise that will help them to resolve new issues creatively (van Merriënboer, 2007). The risk of applying real-world learning, making the teacher's professional and authentic environment the place of learning, is that the learning tasks and problem-solving in a classroom may impose excessive CL or mental effort on learners and, as a consequence, seriously hinder learning (van Merriënboer &

Sluijsmans, 2009). CLT, developed in the late 1980s by John Sweller and colleagues (Sweller, 1988; Sweller, van Merriënboer, & Paas, 1998), has established principles for lowering the CL for learners engaged in complex learning. In order for learning of complex cognitive tasks to be effective, instructional control of CL is crucial (Paas & Kester, 2006).

Exit from teaching by novice teachers has become rampant in recent years, especially prior to the world financial crisis and in recent years since the recovery, when job change was easier (Ewing & Manuel, 2005). By some estimates, half of new teachers come to occupy teaching jobs vacated by instructors with 5 years experience or less (Center for Innovative Thought, 2006; Clandinin, Downey, & Huber, 2009; Riley, 2011). While the rates vary, 40%–50% of teachers leave the profession over their first five years, and their replacements will also leave as well at the same rate (Ravitch, 2011). The trend has continued, as 8% of teachers are leaving the profession per year, and novice teachers leave at rates two to three times as high as those with a comprehensive preparation, and these attrition rates are even greater in high and low poverty schools (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). In the United States, poor teacher education is sometimes made responsible for this attrition (National Council for Accreditation of Teacher Education, 2010–2012); some credit the phenomena of burnout (Goddard & Goddard, 2006; Korthagen, 2004, Maslach, 2003; Maslach & Leiter, 2008), and others a lack of teacher support (Center for Innovative Thought, 2006). Researchers have blamed the exodus on teacher resilience, self-efficacy, beliefs, values and emotions (Hong, 2012). There is a confusing dichotomy that Rinke (2006) noted, the question of whether the causes of such attrition are to be found within individual teachers (experiencing burnout) or whether the problem is contextual (lack of school support, school climate) (Clandenin et al., 2015). A lack of full preparation during recruitment contributes to the problem (Sutcher, Darling-Hammond, & Carver-Thomas, 2016).

Cognitive psychologists consider the complexity of teaching itself as contributing to teacher frustration. Teaching involves the enactment of many complex skills, and so requires what CL theorists technically describe as complex learning. In their study of CLT and the difficulties faced by novice teachers, Moos and Pitton (2014) cited the overwhelming amount of simultaneous activity required of novices and the vast expectations placed on them. Because of the context of classroom complexity, novice teachers report a feeling of being overwhelmed (e.g., Carre, 1993; Kagan, 1992; Wideen et al., 1998). Feelings of helplessness, frustration or anger are prominent in teaching and learning to teach (Hargreaves, 2005; Kelchtermans, 2005; Olsen, 2010; van Veen & Lasky, 2005). Feldon (2007a), one of the primary researchers who interprets teacher frustration within the framework cognitive psychology, describes the experience of being inundated in terms of available cognitive resources in the classroom, and describes how cognitive overload severely limits novice teacher ability and adaptation in complex classroom environments. According to Sweller (1989), cognitive overload happens when the totality of external and internal stimuli and cognitions are greater than mental resources. For the novice teacher in the complex classroom, overload happens when demands within a classroom of students cannot be met by cognitive resources. Cognitive overload may have heavy consequences, for, as Clark (2001) suggested, “when working memory is exceeded, the more recently learned (and presumably more effective and less destructive) strategies will be inhibited in favor of the older and more automatic and destructive alternatives” (p. 274). Feldon (2007a) cited multiple studies on cognitive defaults in education, how CL forces teachers to substitute difficult techniques with easier practices; a teacher trained in an effective disciplinary technique might default to a more authoritarian response under increased CL, and may acquire only errors and inefficient strategies due to the prevalence of CL in problem-solving. Performance errors abound when teachers continually default to them in the presence of inefficient CL (Feldon, 2007a).

Many preservice teachers have been educated well and prepared for the classroom. However, a great portion of the learning that happens for them occurs after teaching begins, as novices must learn on their feet for years before reaching the levels of greatest effectiveness (Gilbert, 2005; Rice, 2003). Teacher learning must be seen as a compilation of basic skills that make it easier to access higher resources (Anderson, 1987). However, research indicates that first-year teachers dealing with behavior management are not given the tools needed (Smart & Igo, 2010) and that major conflicts exist between preparation programs and actual classroom situations, where teachers experience overwhelming frustration and where classroom ecology (the interaction of a person with their environment) must be taught (Wideen, Mayer-Smith, & Moon, 1998). This research considers cognitive overload or excessive mental effort as resulting from deficiencies within training that could be avoided with greater attention to the procedural learning models of cognitive psychology, especially with reference to CLT. The phenomenon of CL in the classroom may be a decisive and relevant contributor to attrition. CLT explains a great challenge faced by novice teachers (Feldon, 2007a; Moos & Pitton, 2014) in a time when better explanations are needed. CLT offers a framework for understanding novice teacher frustration; this research considers novice teacher attrition rates as a sign of failure in teacher preparation and explores the cognitive processes of novice teachers as they interact with the classroom environment, where breakdowns occur that may lead to teacher frustration, unhappiness, and, consequently, greater attrition.

Research of novice teacher experiences by cognitive psychologists indicates a need to identify areas of CL. According to several studies, the most straightforward pedagogical practices, basic classroom management problems and the content of the curriculum represent the entirety of the CL a novice teacher can handle (Borko & Livingston, 1989; Sabers, Kushing, & Berliner, 1991; Swanson, O'Connor, & Cooney, 1990). After reviewing research into teacher automaticity and teacher CL, Feldon provided direction for future research in the area of teacher automaticity and indicates the relevancy of CL.

> Through the investigation of the dynamic relationship between CL, teacher training, and teaching performance, research utilizing the dual-process model of cognition has the potential to shed light on teaching preparation and performance in new ways. When integrated with efforts to identify ecologically meaningful patterns in classroom interactions (e.g., Nuthall, 2005; Wideen et al., 1998), monitoring dynamic fluctuations in the cognitive load of teachers will provide a comprehensive, multi-tiered framework for understanding their performance. This will shed further light on effective techniques for preparing novice teachers to enter the classroom successfully. (Feldon, 2007a, p. 133)

Exploring the essence of CL through the life experiences of teachers is the first step in the exploration of dynamic interactions between CL and teacher performance.

There are some limited examples of attention to CL in teacher training that demonstrate its relevancy. The literature of deliberate practice includes references to learning designs that focus learning and avoid higher levels of CL. While there are many different frameworks for teacher professional development, this study focuses on the work of Lemov (2016; Lemov, et al., 2012) as exemplary for design of teacher learning for his specific analysis of tasks of teaching. While Lemov is not a cognitive psychologist, his methods of research and his design of teacher practice are a powerful mirror of CTA principles. The work took into account the limitations of working memory and mental effort, and demonstrated a reliance on the goals that also inform CTA. The research of this dissertation hopes to form a bridge between Lemov's work in developing teacher procedural knowledge and that of cognitive psychologists.

Cognitive psychology and, specifically, CLT offer decisive recipes for teacher success and frustration in the classroom, and the exclusion of the relevant phenomena associated with CL from teacher education has left a gap in the research of teacher support.

The Phenomenon Cognitive Load is a Profound Idea Resistant to Fuller Understanding

This section considers how CL is a phenomenon that demands a deeper thought process. To explore this phenomenon requires one to go beneath what is superficial or seemingly obvious. CL is both an idea and an experienced phenomenon that resists fuller human understanding and therefore requires research that will deepen understanding. The psychological construct cannot simply be superficially defined as an amount of mental work to accomplish a task; psychological, environmental (classroom), and domain and task-specific factors contribute to the phenomenon's multidimensional nature in teaching. In regards to psychological factors, CL researchers have demonstrated that levels of CL are influenced by demand expectations, the real effort that a performance expends, the effectiveness of the performance in meeting goals, the complexity of the environment and the problems to be solved, as well as individual differences in willingness, memory development, training, timing, stress, fatigue and past experiences of success (Moreno & Park, 2010). CL levels are impacted by all of these elements.

A focus on the teacher undergoing CL further deepens the reality to be explored. A teacher's cognitive processes, their performance and their layered tasks and interactions are complex, singular and unique. Each teacher is an individual, and individual differences take multiple forms; CL is impacted by a teacher's learning preferences and modalities, the impact different environments have, cognitive styles and abilities, and levels of intelligence (Plaas, Kalyuga, & Leutner, 2010). CL also will vary based on complexity of tasks or solutions chosen, and whether the learning design that practices these tasks is wasteful or useful (Brünken, Seufert, & Paas, 2010). The real-life environment that influences learning and problem-solving is also complex; the classroom itself is a massive puzzle that must be put together minute-by-minute. The literature review will expand on the nexus of complexity that influences CL.

CL also is resistant to fuller understanding because, as a psychological construct, the phenomenon resists direct observation. Those who observe teachers have no direct access to what is internal to novice teachers, so novice mastery of skills and problem-solving is most often measured through observation of teacher performances. Observers have no direct contact with specific fluctuations in mental effort that indicate a novice is in need of help or an expert has mastered teaching skills. This researcher has encountered no known rubrics or observational designs for teachers that include levels of automaticity and CL as factors; rubrics are more often concerned with environmental factors that result from classroom teacher performances, efficient practices and events occurring outside of the teacher, and not what is happening internally, teacher cognitive processes. Protocols that access the internal CL of novice teachers are necessary, but developing these requires a more complete exploration of the phenomenon.

Finally, the understanding of CL is resistant to the natural attitudes of expert teachers. To analyze a novice teacher's CL, it is not enough to throw an expert teacher at the problem, and it might complicate matters. Expert teachers have produced a multitude of evaluative rubrics, and many different approaches to problems and goals endemic to classroom teaching. However, cognitive psychology has demonstrated that expert reports on what constitutes their own success are often highly inaccurate; Feldon and Stowe (2009) summarized empirical evidence indicating that experts are often unable to report the steps that represent their own expertise, since these steps are done automatically, or without a lot of conscious thought. Since most experts draw solutions from very complex long-term memory schemas, they are often unconscious of the supportive, automated subtasks that make them successful, and are often indifferent to teaching these. "Ironically, the mechanisms that enhance performance also limit the ability of experts to fully articulate the strategies and procedures that they use to solve problems in their respective domains" (Feldon & Stowe, 2009, p. 105). If expertise itself is the problem, CTA is the science developed as a solution. CTA has developed techniques for decoding expert practice to uncover the procedural knowledge required for skilled performance. CTA procedures are a reliable and valid guide to decomposing complex tasks of teaching, the analysis of classroom cues (if) and decisions (then), and the movement of one production in sequence to the next that compose expert teaching. (Clarke, Feldon, van Merriënboer, Yates, & Early, 2008) It would be a basic assumption of CTA that if a culture of expert teachers simply assumes they must be qualified teachers of expertise, and that they need not study tasks and subtasks of expert practice and the designs of learning to optimally transfer these, then a massive gap is present in teacher education (Hoffman & Militello, 2014). This research, to be reviewed in the next chapter, indicates the blind spot in expert valuations of novice teacher practice and problem-solving.

The Phenomenological Pathways to the Essence of Cognitive Load

This research attempts to understand more fully CL in the context of novice teacher practice, exploring the phenomenon in lived experiences. This study will consist of in-depth phenomenological interviews and observations of novice teachers in order to hear their stories, which are "a way of knowing" (Seidman, 2013, p. 7). Each novice teacher is a microcosm, and the words they use in telling their stories give access to their experience of learning to teach. In-depth interviewing explores the experience of novice teachers and how they make meaning of that experience. Through the voices of novice teachers, phenomenon of consciousness may be explored and understood with new depth. (Pollio, Henley, & Thompson, 1997; Seidman, 2013; van Manen, 2014) Yet the processes of developing interviews and analyzing the phenomenon of CL as experienced in classroom settings are in no way simple. Phenomenology, a descriptive study of lived experience, must deeply explore the meaning of that experience (van Manen, 2014). Currently, teachers simply live through the experience of CL. This research subjects these experiences to the act of attention, to an intentional gaze that will allow the lived experiences a way to meaningfulness (Schutz, 1967).

The literature review of the next chapter and the third chapter's methodology represent two phenomenological epochés, conscious turns from both the natural attitude to novice teaching and from the strictures of theory. The first epoché consists of a dis-position and displacement from the natural attitude of teacher trainers to consider the findings of phenomenon of CL as explored by psychologists. The second epoché, performed in the third chapter, puts clears a ground for descriptions of the prereflective experiences of teachers. This bracketing of teaching attitudes and psychological theory, however, leads to their being brought together in an analysis of lived experience. The relevant and decisive phenomenon's resistance to understanding can be overcome through the phenomenological reduction and the theme-building that is the result.

Statement of the Problem

Briefly, the problem of a phenomenology of novice teacher CL is the overcoming of the tension between hermeneutic (experiential accounts of novice teachers) and categorical (theoretical) descriptions of the experience of mental workload; this research attempts to model an interpretive process that gives a depthful understanding of the experience of CL based on novice teacher prereflective experiences.

CL is a construct of psychology that is both relevant for the learning design of teachers and resistant to understanding. This is the essential paradox of CL, that it has a dramatic impact on teacher success or failure to attain expertise, but that it is an unconscious fact. Phenomenology breaks through the natural attitude that human beings fall back into in regard to their experiences (van Manen, 2014). Both novice and expert teachers also bring their particular natural attitudes, with a set of theoretical frameworks different than cognitive psychology. Novices fall back on their experiences as students and must learn to think like a teacher (Darling-Hammond, 2006). Expert teachers hope to transfer the skills that are at the forefront of their active, working memories, and may remain unconscious of the more automated skills that truly support their success (Feldon, 2007a; Feldon & Stowe, 2009). It is also the essential paradox of a phenomenology of teaching that novice teachers act and think and solve problems and learn within a life-world with its own sets of rules, mental and environmental conditions. Novice teachers without experience of this life world may be ignorant of these rules and conditions. In terms of phenomenology, complications arise when novice teachers give accounts of a phenomenon that is a deciding factor in their problem-solving and learning, but that is known and described by psychology and its learning designers in a way that is foreign in teaching culture.

Issues of validity and reliability in phenomenology become complicated by this tension; the voices of teachers describing rich experiences must be heard, and the researcher's interpretive goals cannot eclipse these descriptions. Pollio, Henley, and Thompson (1997) described a categorical and a hermeneutic tension (1997, p. 37). On one hand there is a hermeneutical interpretation (of the rich description of a novice teacher) that is motivated by the removal of researchers and their theoretical frameworks from the enterprise in order to make subjective expressions possible. On the other hand, there are categories that guide analysis, and the scientific community's interpretation that makes objective science possible. There is an interpretive circle between these that both makes experience meaningful and demonstrates that the data obtained from the rich descriptions of teachers is independent of the researcher's tools of measurement or analysis (Pollio, et al., 1997). The tension is overcome through a rigorous method of interpretation that will be utterly dependent on first-person description, but that also codes and categorizes experiences with accuracy in a way that allows those raw experiences to evolve into a heightened understanding (Saldaña, 2014). Data analysis methods in phenomenology allow the researcher to hear the voices of novice teachers, their lived experiences of the phenomenon and the meaning that they give to it only through such an evolution. To enact this phenomenological research and arrive at the eidos or essence of CL, this research utilizes the theoretical framework of CLT, the techniques of CTA, and the language and techniques of Doug Lemov as tools to analyze and code the raw data of teacher accounts and stories.

Purpose of the Study

The purpose of this phenomenological study is to explore the phenomenon CL through the lived experiences of novice teachers in the complex classroom environment. While cognitive psychologists may present a general theory, CL as experienced by novice teachers in the life-world of a classroom is a profound idea resistant to fuller understanding. Rich descriptions and insights regarding teacher CL will be reflectively exposed, and the experience and meaning will appropriate new depth and greater relevancy for teacher learning design. Specifically, the study is focused on stories of teachers who practice recurrent classroom techniques and solve problems, and how their enactment impacts cognitive processes, teacher emotions, and ongoing development. Thematic reflections on the impact that CL has on novice teachers, as in teacher emotions, self-concept and motivation, overall practice, effectiveness in managing and instructing the class, will only arise from the original accounts. Based on accounts of prereflective experiences, the study explores the relevance of specific learning designs for teacher expertise transfer.

Research Questions

Phenomenological questions are different from other qualitative research questions (van Manen, 2014). Research interviews are phenomenological when they recognize the transitory nature of human experiences, that understanding an experience (what it is) is entirely subjective, that lived experience is the foundation of the phenomenon, and that emphasizes meaning and the context of meaning (Seidman, 2013). Phenomenological questions are different from merely qualitative study questions, in that they strive for the essence of a prereflective experience. In the case of studying CL, the study cannot arrive at this experience by explaining the theory to teachers then asking them to share their opinions about it; the phenomenological question asks 'what is the experience like?' of the participant (van Manen, 2014). The questions of this research, therefore, are phenomenological in that they are designed to elicit lived experience descriptions, the accounts of something a teacher lives through, to develop themes from this experience, and to eventually create composite structural and textural descriptions of this experience (Moustakas, 1994). Phenomenological questions must allow teachers to share the stories of what has happened, their cognitive processes, within the life-world of the classroom (van Manen, 2014).

The purpose of this study is met by answering the following questions:

1. What is the experience that novice teachers have of different types and levels of mental effort in complex classroom environments?
2. How do novice teachers become aware of their own CL (i.e. emotions, student responses, confusion, frustration, self-concept, automaticity, efficiency)?
3. What do novice teachers experience as the consequences of different types of CL on their development of expertise?
4. How do novice teacher perceptions of CL provide insight, if any, about the relevance of specific learning designs for teacher expertise transfer?

Significance of the Study

Performance and Informance

An in-depth understanding of CL from common classroom experiences will help novice and expert teachers perceive their own learning and problem-solving and to focus their performance. Teaching is not all performance, exterior acts that have effects, but is also what this researcher calls *informance*, an internal group of interactions in working and long-term memory that must be noticed and explored through introspection. In contrast, CLT has been established through experiments with performance in learning, exterior results, and teacher professional development also has been guided by performances and effects on students, events outside the teacher. Informance happens within, where processes in working memory are constructed into schemas, where masterful schemas slip in and out of working memory, where the mind takes in a student and makes a judgment from internal resources, decides among multiple responses, and then brings forth a result that is both cognitive and only then exterior. This interior world is a new territory for teaching, and the maps through this territory are unclear. The protocols developed in this research are meant to change the paradigm of professional development with tools that elicit the subjective experience of teachers and allow their rich descriptions to give shape to a phenomenon that is decisive for their learning. CLT and CTA do not, alone and of-themselves, ascertain the amount of effort required by a teacher to achieve a higher level of performance and problem-solving; teachers do. This is why phenomenological method must bracket theory and established analytical process, to allow teachers a voice. Teacher professional development must come to mirror phenomenology's ways, producing "depthful" (van Manen, 1994) understandings of the interior structures of cognition.

Novice Teacher Professional Development

Such depthful understanding of CL will enhance all areas of novice teacher instructional design. Acquiring expertise in teaching should no longer be a mystery, and practice rationales be enigmatic formulas; novice teachers should understand their own development, how to triumph or avoid pitfalls. Paas, Renkle and Sweller (2003) described the informance, the progressive building of expertise that novice teachers might benefit from, in this way:

> A reduction in intrinsic cognitive load reduces total cognitive load, thus freeing working memory capacity. The freed working memory capacity allows the learner to use the newly learned material in acquiring more advanced schemas. A new cycle commences; over many cycles, very advanced knowledge and skills may be acquired. (p. 3)

This is theoretical language that describes what must become a living sense within a novice teacher. Teaching needs an interior turn and a new paradigm for the study of expertise and teacher adaptation to classroom complexity. An expert teacher is one who has inwardly triumphed, exercising working memory processes and integrating them into larger schemas, and any concept that assists novice teachers with this process has the potential to improve teaching. Teachers become mired in cognitive defaults, inefficient practices, when CL becomes too great and decreases effectiveness. The growth of teaching as a profession demands the development of schemas and automaticity, which means the reduction of CL on a teacher. This study will contribute to how teachers perceive their internal technique, their internal mastery through the lens of CL and automaticity. While it must consider how environmental factors impact teacher learning, depthful understanding of interior structures will help teachers to evaluate their own levels of learning and develop cognitive strategies for acquiring new skills. This research assumes that such informance precedes real teacher support, and support within the theoretical framework of CLT will have as a first step the perception and description of the phenomenon. The identification and reduction of areas of CL is a means of freeing teachers for more creative and advanced initiatives in classroom education, and a step toward more effective teaching.

Expert Teachers

Teachers who have achieved expertise will not be able to hand it on without a depthful reflection on their own performances and informances. It is near impossible to hand on one's expertise without an interior sense of how the simplest elements of problem-solving interact and may be instructionally manipulated for higher levels of teacher learning. If teacher educators, the experts, constantly demand an efficient output or complex schemas of a novice without providing a manner in which these are put together in cognition, or without a description of the cognitive elements of which they consist, learning will be frustrated. For example, according to Paas, Renkle, and Sweller (2003), identifying the tasks that represent intrinsic and germane CL is foundational to CTA. CTA decomposes larger schemas to simpler steps, into tasks that omit interacting elements and reduce load in the teacher. CTA asserts that omission of essential interacting elements of teaching may compromise higher levels of understanding, and CTA attempts to both identify and develop the more complex interactive tasks of teaching. Simultaneity and automaticity in large schemas must be built from smaller skills, the most basic skills and acts of teachers (Paas, Renkle, & Sweller, 2003, p. 1). This type of subtask identification and practice may not be the focus of professional development because teacher experts are either unconscious or indifferent to these subtasks of teaching. Feldon and Stowe (2009) cited research on expert self-reporting that indicates a massive blind spot in all domains of expertise transfer. An expert in any field may develop too far, automate too much, and may no longer be conscious of the informances that lead to real success. In trying to hand on expertise, experts usually focus on their own large schemas, what is most present to their working memories, what they are currently working on, the performance of complex classroom initiatives, and in doing so they ignore what novices need, the subtasks that support and make possible their own more complex processes (Feldon & Stowe, 2009). The reason teacher programs fail their novice teachers is not due to a lack of experts. It may be because of our many experts, and failures to realize that expert cognition has such different dynamics than novice cognition. Because an expert is an expert teacher, they may presume they have the skill of teaching teachers expertise. But the more expert one becomes, the more automated the subtasks learned within the trenches, the more unable one may be to recognize and hand on what counts.

A Turn From Constructivism

Constructivism grants such experts a theoretical reprieve. New teacher instruction is most often done in a constructivist framework, where teachers are left to construct the reality of a classroom through reflective practice, often irrespective of how elements of their performance are presented. Current preparation of teachers may be characterized as offering minimal guidance to teachers (Green, 2014), and constructivism is one justification for this approach (Steffe & Gale, 1995). Since knowledge is constructed by learners, constructivists assert, learning designers provide goals and the minimum of information and allow the learner opportunities to construct; this theoretical framework asserts that since learning is unique to individuals, common formats and strategies will not be effective. Learning design in constructivism, offering minimal structural support to teachers, has been shown to be an ineffective approach to teacher preparation (Kirschner, Sweller, & Clark, 2006; Moreno & Park, 2010; Sweller & Chandler, 1991; Vogel-Walcutt, 2011). According to Green (2014), a culture of autonomy allows teachers to "succeed or fail on their own terms, with little guidance," and the prescription preserves "a long-standing culture of abandonment" (p. 15). Cognitive psychology offers a better framework, and a rich description of CL based on the lived experiences of novice teachers is a first step to changing the character of teacher preparation.

Teacher Happiness

While it may seem inappropriate to speak of in a scientific research dissertation, the greatest significance of this research may be found in identifying blocks and pathways to teacher happiness. Making teachers happy is a significant step to ending teacher attrition. The research of Csikszentmihalyi (1997) on human happiness and flow is instructive. The author identified a state of flow that a person enters when confronted with a task that is both challenging and that fits his or her skill set. When a person is involved in very challenging activities but lacks the skill to meet them, he or she will experience worry or anxiety. When the challenge faced is far less than the skill required, the person will experience boredom and apathy. But when the activities are both challenging and demand high skill, the person will become deeply engaged, do great work and feel a higher level of satisfaction. It is the duty of teacher trainers and leaders to bring teachers to this place of flow, where skills match the challenges and are not overwhelmed by these, and a depthful understanding of CL will contribute to this.

Evaluation Methods

Current practices of teacher observation most often focus on skills displayed externally, or student responses, or the data of achievement, but such observation does not focus on working memory capacity or the CL experienced by teachers. A teacher, an expert coach, or a researcher may not be able to perceive the sources of CL in the classroom or identify levels of automaticity in specific practices unless observation skills are refined. (de Jong, 2010). The conceptual analysis of features of automaticity is to a large extent feasible, but methodologies that might situate automaticity in the classroom need more development (Moors & De Houwer, 2006). In-depth phenomenological interviews may contribute to evaluation and observation techniques. This study takes a direct approach to the lived experience of novice teachers, through in-depth phenomenological interviewing (Seidman, 2013). Analyzing the phenomenon as described by teachers and inaccessible in observation demands a new way of looking at teacher practice that diverts from most evaluative rubrics currently in use. New tools and protocols must be developed to explore the dimensions of CL and the informances of teacher learning, to explore the novice teacher's cognitive processes. The methods of analysis in this research generate depthful descriptions and coding that takes account of teacher mental processes and tasks, and these methods may also be applied to evaluative protocols for novice teachers. The multidimensional nature of CL requires views of the phenomenon from many different angles and perspectives in real situations and learning environments. Analysis of accounts and the phenomenological reduction will be assisted by findings that generate CLT, the analytical tools and language of CTA, as well as the exemplars offered by Doug Lemov specific to teaching. The work of Lemov (2016) utilizes task analysis techniques similar to CTA practitioners. These designs of novice teacher practice demonstrate an affinity with CLT's framework to facilitate schema acquisition and mitigate the effects of CL (Lemov, et al., 2012). This study creates a bridge between the taxonomy and practice designs of Lemov and colleagues and the work of cognitive psychologists, even as it explores the multidimensional experiences of novice teachers. The tools, language and models necessary to explore the complexity of teachers and their classrooms and the experience of CL may advance the evaluative practices of teacher educators.

Assumptions, Limitations, and Delimitations

Assumptions

The researcher assumes that the methodology adopted to explore the phenomenon CL will be able to overcome the paradox of relevancy and resistance to fuller understanding. The categorical element of the study and the hermeneutic element are fundamentally conflicted without a rigorous guiding methodology. Phenomenology itself is a methodology, a turn from natural attitudes and theory to wonder at a specific phenomenon, and a turn toward openness to the study focus, the lived experience of novice teachers. The voices of novice teachers, it is assumed, will be heard beyond the natural attitudes to teacher learning and the theories of cognitive psychology. The hermeneutic element consists in eliciting teacher prereflective experiences and will demand a bracketing of the researcher's theoretical and experiential presumptions. The categorical element will test and compare the teacher's accounts and language and descriptions without eclipsing the subjectively constructed descriptions of teachers. The analysis will utilize imaginative variation and construction of themes that must remain true to the transcribed interviews and validly refer back to those accounts. The primary assumption is that novice teachers will contribute to a depthful exploration and elaboration of the experience and the meaning of CL for teacher problem-solving and learning.

Limitations

Novice teacher accounts of their internal experience may be flawed, both in terms of self-perception, but also in that novice teachers may be nervous or uncomfortable speaking about the mental effort involved in learning to teach. The interview questions and protocol (see Appendix A) are designed to get novices sharing their stories, both in the open-ended nature of questions and the non-theoretical language employed, and to elicit the lived experience. However, teachers are not used to providing rich descriptions of their cognitive processes, the thoughts and feelings and decisions that guide their actions.

Delimitations

The novice teachers of this study will be selected according to criterion sampling. The one criterion to be applied is that the teacher must have spent less than two years in the classroom. Using Seidman's (2013) three-interview process, further clarity about teacher background, educational experience, contexts of prior learning and theoretical framework will also be elicited.

Summary

This is a phenomenological study of CL as experienced by novice teachers. The phenomenon is entirely decisive and relevant to expertise transfer processes in which novices are engaged. CL is also a phenomenon that resists understanding, especially in the craft of teaching. This latter aspect makes its exploration in phenomenology both a challenging adventure and a subject requiring great rigor. In this study, the voices of novice teachers will be heard, and their descriptions analyzed in valid and reliable manner.

The literature review will consider why phenomenology is the most appropriate beginnings for the study of CL, exploring the essence of the experience. It will represent a first phenomenological epoché, a turn from the natural attitude to teacher learning and a turn toward concepts and practices of CLT and CTA. The literature review deliberately surveys and summarizes CLT, the techniques of CTA and the particular practical applications of Doug Lemov in order to both bracket these and to develop the analytical tools for coding, theme-building, imaginative variation, and phenomenological reduction. Paradoxically, the methodological section of chapter three will represent a second phenomenological turn, one which brackets most of the material of the literature review. Theoretical frameworks and categories of teaching must be put aside, as much as possible, in the process of listening to teachers. The methodological section explores how in-depth phenomenological interviewing will expose the phenomenon, and then describe how analysis will be done that builds themes, comparing teacher accounts and categorizing those accounts. The goal is not to prove a hypothesis or to test CLT, but to enrich understanding of the phenomenon.

Chapter 2: Literature Review

This literature review offers a comprehensive survey of literature relevant to the phenomenological study of CL in the life-experiences of novice teachers, the learning and problem-solving within the complex classroom. This phenomenological study will utilize in-depth interviews to study a phenomenon that cognitive psychologists claim is decisive and relevant for teacher expertise transfer. CL is usually studied as a psychological construct (i.e., an unseen variable that impacts learning and is known through experimentation that changes learning variables) in order to draw theoretical conclusions (Moreno & Park, 2010). The claim of this study is that a phenomenological investigation of CL will deepen appreciation of its relevancy to teacher learning design. The focus of this phenomenology of teaching is the life-world of teachers and their descriptions of life experiences regarding mental workload in problem-solving and acquiring new skills. Hence, the literature review presents evidence relevant to the life-world of teachers, the complexity of their tasks and their classroom environments, and the state of research on the challenges of expertise transfer, specifically as these may be applied to teaching. The research literature of expertise transfer as designed by CTA and the CLT that informs it are presented to assist in categorizing and coding teaching events and stories as they relate to the transfer of expertise.

This review serves the phenomenological goals of the study. There are natural attitudes associated with teacher learning that must be bracketed in order for a researcher to truly allow the voices of teachers to be heard (Moustakas, 1994; Pollio, et al., 1997; Seidman, 2014; van Manen, 2013). In-depth phenomenological interviews must provide all relevant data for this study (Seidman, 2013), but reviewing literature on expertise transfer in the classroom provides categorical knowledge that will help create an interpretive circle for the hermeneutic to be applied to teacher transcriptions (Pollio, et al., 1997, pp. 36–46. The interpretive circle that studies

CL must include techniques of CTA to make sense and give meaning to observations and interviews, since this science studies CL and optimal expertise transfer and problem-solving processes. Valid interpretation of teacher experiences will depend on in-depth descriptions of particular, subjective instances or events, but also on a textural and structural analysis that includes the many angles of interpretation.

Of the four types of literature review identified by Cooper (1989), this review is meant to be both integrative, in that it presents the current state of knowledge in branches of cognitive psychology regarding CLT and its impact on teacher learning design, and theoretical, looking at the theories that account for the sources and types of CL in the classroom. Articles were identified from various sources investigating the development of CLT, expertise transfer, CTA and inventory development. Databases included the ProQuest databases, ERIC, Education Database, and Dissertations &Theses Global, Tyler &Francis Online, Wiley Online Library, ProQuest Central, JSTOR, and Sage Journals Online, all accessed from the Concordia University Library (2016). The questions that guided the search were: (a) How does CLT inform teacher preparation and expertise transfer; and (b) How does phenomenology explore profound ideas resistant to fuller understanding? Articles and books were included based on their centrality in presenting CLT's premises and development. The research included demonstrations of valid and reliable models of expertise transfer and the measurement of CL in several professional domains that could extend to classroom teaching. Research was also reviewed that directly addresses teacher preparation theory and practices in various alternative models reviewed.

Conceptual Framework

According to Moustakas (1994), the review of literature must also present how the research being done differs from prior research in terms of its questions, model, methodology and the data being collected. This research represents the convergence of three different worlds of thinking and practice. First, cognitive psychology has developed CLT to account for learning outcomes in expertise transfer design and CTA facilitates the optimal building of long-term memory schemas. Second, teachers who represent expertise in their field possess an amalgam of discrete skills performed within the complex life-world of the classroom, and a culture that either supports or hinders their acquisition. Finally, phenomenology promises methods to grant access to the prereflective experiences of novice teachers, to strip what is taken-for-granted from professional development, and explore the meaning structures of their cognitive processes. Phenomenology has the potential to bring together what cognitive psychologists consider decisive for expertise transfer and the experience of novice teachers learning and problem-solving in classrooms.

To integrate these worlds of thinking and practice, the applied research method of phenomenology will explore the experiences of novice teachers of the phenomenon CL. This integration is unique, and needs rational justification, but also has the potential to add to and revise teacher education and professional development. Phenomenology proves no hypothesis, and does not add to theory (van Manen, 2014), but can deepen understanding of the reality experienced each day by novice teachers as they attempt to solve problems and acquire new skills. Phenomenology as a method has the potential to remove categories that hinder the integration of cognitive psychology and teacher professional development. By taking up the phenomenological attitude this research explores of the active minds of novice teachers, the mental processes that represent the entirety of their learning.

The Epoché, the Natural Attitude to Teaching, and Scientific Theory

To take up the phenomenological attitude, the epoché, is to step away from more naturalistic attitudes toward expertise transfer. According to Moustakas (1994), the Greek word epoché means to refrain from judgment, to turn from the everyday and ordinary perception of reality. The knowledge we hold judgmentally in the natural attitude is built on the presupposition that what we perceive in nature is actually there, while epoché demands a new way of looking at things, a new learning to see. Phenomena must be looked at again, in a new and naïve way, with our senses and intuitions opened wide. (Moustakas, 1994) For Edmund Husserl, the basic concept of phenomenology "denotes a science, a system of scientific disciplines. But it also and above all denotes a method and an attitude of mind" (Husserl, 1964, pp. 18–19). For Hussurl (1977), the founder of phenomenology, the epoché and its resultant reduction are the minimum requirement of a phenomenological study (Englander, 2016). Similarly for Heidegger (1962) the expression primarily signified a methodological concept, and for Merleau-Ponty (1962) the science was only accessible through its method. While there are many methods associated with phenomenology, "It's always about the epoché" (Morley, 2010, p. 293). The role of epoché, or bracketing, in qualitative psychology and phenomenology requires turning from the attitude of natural science, where cause and effect govern exterior objects, where even mental events are considered natural objects, toward the life-world or the world of everyday experience, the world as it belongs to psychological subjectivity (Davidson, 2003).

This research's epoché involved two movements that first bracketed presumptions, common understandings and, second, bracketed psychological explanations, so that the real mental limits of novice teacher working memory would appear in real experiences. First, the literature review of teacher CL included a turn from everyday judgments, the natural attitudes, of both expert and novice teachers regarding teacher practice, by focusing on the theories of cognitive psychology. While this epoché suspended common beliefs and judgments held by experts in current teacher professional development, it did not represent a complete bracketing (ie., of psychological categories and theories). The second epoché, the conditions for which are laid out in the third chapter, set aside the presuppositions of CLT and CTA in order to allow the phenomena of CL to be perceived naively and with fresh eyes. The applied research portion demanded the bracketing of the theoretical framework in order to have a naïve vision of the lived experiences described by novice teachers.

For this first epoché, this review itself represents a turn from collections of cultural and professional convictions by which educators usually assign the causes of teacher effectiveness or ineffectiveness in navigating classroom complexity. Every person, expert or novice teacher, teacher-coach, student, administrator or parent, has a natural attitude to the art of teaching, a set of explanations for teacher behaviors. The teacher, administrator or coach especially has a way of considering and explaining teacher overload, frustration, or inability to handle extreme complexity: difficult students, low pay, poor self-management skills. Or an observing coach could simply conclude of a struggling teacher, “This teacher is not teaching like I do.” The teacher in turn may consider their problem-solving struggles the result of lack of charisma or natural-born teacher ability, or blame the students for their struggles. The researcher’s setting aside of the natural attitude to teaching begins through the literature review by presenting a new way of seeing teacher learning with new tools and theoretical models, as these have been applied to expertise transfer in other fields.

Reduction, Being Led Back to the Essence of Teaching Experiences

The second step in the method of phenomenology involves the phenomenological reduction. Embree (2011) considered the phenomenological method as a mental operation, a reduction, that is the result of a researcher's attitude adjustment, their stepping away from the natural attitude. The researcher moves past what is everyday to the pure ego in order to gain fresh perspective, looking at the experience of the world as if for the first time. The word *reduction* refers to being led back, specifically to the source of meaning. Phenomenologists bracket their natural attitudes and scientific theories in order to experience the world or other persons naïvely, with wonder and openness, and then are led back to the essence of what is studied (van Manen, 2014). Reduction is meant to bring precision to a research inquiry (Giorgi, 1997). Things and events in the world cannot be taken for granted as they are not always what they seem—the reduction helps researchers to discover how phenomena come to be, allowing what is studied to simply be, to experience things as they are (Moustakas, 1994). Since life experiences as reported by individuals are the source of evidence for phenomenological research, the researcher must be present to those experiences. This involves intentionality on the part of the researcher, intentional acts that perceive, or make present in consciousness, a particular object (Moustakas, 1994).

The prereflective life-experiences of novice teachers and the meaning they give those experiences are the object of this turn (Moustakas, 1994; Pollio, Thompson, & Henley, 1997; Seidman, 2013; van Manen, 2014). The novice teacher's subjective production of these experiences and their original descriptions (as these are accurately transcribed) form the core of analysis. The epoché makes possible this material, and after this reduction has been made, the analysis and theme building preserves this core experience and is validated from it. The way the first research question is framed ("what is like for novice teachers…?") elicits the mental process as it is lived, and avoids the type of question that may put teachers in a position to theorize or merely talk about their mental workload (van Manen, 2014).

It may seem contradictory to claim this research turns from CLT in order to perceive and describe better the phenomenon of CL, that the bracketing of a psychological construct will grant access to the mental workload that is posited in the construct. There are two CLs. There is CL as a theory presented in scientific research literature, and there is a teacher's mental limit as it really is experienced by teachers in the classroom. Phenomenology integrates both realities of CL through what Moustakas (1994) calls intentional experiences. An intentional experience combines the actual experience a teacher has of CL (which itself has intentionality) and the CL that is in the researcher's consciousness, the memory of it, images that present themselves there, in order to give it meaning. So there is the real CL that happens in a teacher in a complex classroom, and then the ideal CL of thought and perception and judgment. These were brought together in dialogue, which led to a fulfillment of the meaning. As the researcher engaged in description, this led "to deeper layers of meaning" through a process that integrated the person, their conscious experience, and the phenomenon being perceived (Moustakas, 1994, p. 96). This review of literature presents the research of CL as it is intended (each different study's single view or angle) and the data collection process took from teacher experiences the object that was intended (from all angles, it remains the same object) (Husserl, 1970). The lenses of CLT, CTA, and complex learning design helped to clarify and focus the researcher on the real experiences that teachers reported. The meaning that theory and research have given the object CL, as understood by the researcher, guided the way the researcher looked at a teacher's real practice and allowed further, more elaborate meanings to develop (Moustakas, 1994).

The interpretive framework formed the core of the conceptual framework for this introduction. The experiences of novice teachers occur in the complex environment of a real-world classroom, in a learning setting that either furthers their skills through supportive learning design or impedes the process and frustrates their goals. Unique perspectives presented by teachers were associated with science and teaching, and were ordered in an objective search for truth. This interpretative description involved an interplay of individual teacher descriptions and the pre-understandings of th researcher, the data of transcriptions with categories associated with a particular learning theory, and the corroborated structures of cognition with an individual teacher's insights. This interplay was the essence of the interpretive framework, but it highlighted its contradictions. For the purposes of phenomenology, CLT provided one particular perspective on learning and did not describe how things really are; dialogue within the interpretive circle means that pre-understandings were not applied dogmatically so as to blind one to the lived experience of teachers. (Pollio, et al., 1997, pp. 45–46). The problem was that all interpretation is affected by some categorically driven perspective, but phenomenology attempts to bracket the perspective that is so constricted to arrive at the individual, in their everyday life. Clarity must be given to the interpretive framework that makes this possible.

Pollio, Henley, and Thompson (1997) claimed that the volume of interview data that in-depth phenomenological interviewing produces demands an interpretive framework, and they survey the range of approaches. For heuristic purposes, they acknowledged different polarities within phenomenology to explore the problem, the categorical and hermeneutic, the nomothetic and idiographic and the structural-corroborative and empathic-verstehen (Pollio, Henley, Thompson, 1997). The categorical contrasts with the hermeneutic. At the categorical pole, qualitative data are organized into "mutually exclusive categories" for the sake of objectivity, while at the hermeneutic pole, the transcripts of life experiences are a text from which no aspect may be given a separate meaning from the entirety (Pollio, Henley, Thompson, 1997, p. 37). An "interpretive circle" (p. 38) must be formed that allows a pure interaction of categories with the text. The nomothetic contrasts with the ideographic. Knowledge is sometimes general (nomothetic) or particular (idiographic); the antinomy arises when one teacher's experience is considered a representative sample, and this polarity creates and interplay between the relative truth of individual teachers and the communal truths of teaching. "Without particular instantiations, the general is never revealed, and without some more general conception, the particular is not recognizable" (Pollio, et al., 1997, p. 42). Without a general conception of teacher expertise transfer, the research may fail to recognize the particulars of teacher experiences and their meanings, and without the particular, general knowledge does not expand. The structural-corroborative contrasts with the empathic-Verstehen. At the structural-corroborative pole, a researcher seeks to apply an apriori structure (CL) to a human experience, while at the empathic-Verstehen pole the purpose of interviewing is for the researcher to live entirely in the lived perspective of the subject studied. One could project a theory onto a teacher (such as CLT), and never know that teacher as he or she truly is. However, that lived experiences "viewed without structural preunderstanding would be inchoate" (Pollio, et al., 1997, p. 46).

How are these apparent contradictions overcome? The interpretive (or hermeneutic) circle overcomes these polarities by creating a dialogue between the interpreter (with all his preunderstandings) and the text (transcribed interviews). CLT, CTA, and approaches to practice reviewed here were brought into dialogue with in-depth descriptions of teachers, the stories of their prereflective experiences. This dialogue gives phenomenology the potential to bring together the prereflective experiences of teachers and a construct of cognitive psychology. Understanding CLT allows one to bracket it, in order to achieve wonder at what novice teachers do, at what happens in their heads. Taking the raw, prereflective descriptions of this experience and allowing these to dialogue with the researcher in analytical processes led back to a fuller essence of the phenomenon.

Review of Research Literature

Research literature on the theoretical and practical elements of teacher expertise transfer has the potential to inform inductive interviews and observations of teachers, and to enhance the interpretive circle of the participants and the researcher. It assists the development and application of analytic coding and theme-building. The relevancy of CL to teacher expertise transfer and the reasons the phenomenon resists understanding are explored in the review.

The literature review consists of three parts. First, the review considers the theoretical framework of CLT and CTA as these may relate to teaching. Second, the review examines the nature of the complex classroom, the complexity of the tasks of teaching, and how the dominant teacher-education model from constructivist theory may not offer significant support in such a learning environment. Third, the review explores the work of Doug Lemov, and demonstrates the affinities with CTA that are within the framework for his taxonomy of teaching and practice.

Section One: Cognitive Load Theory and Cognitive Task Analysis

This first section considers the significant findings of CLT and how these have impacted the way researchers design instruction for complex tasks. This analysis considers the architecture of cognition. It explores research of expertise, the role of schemas and chunking in skill acquisition, the types of load in complex tasks, the effects of complex learning design on expertise, and how CLT has impacted instructional design. It summarizes studies relative to CLT in order to explore the phenomenon as it is actualized in the learning, practice, and subjective experience of teachers in complex classroom environments. The review considers the literature describing the automaticity that results from efficient expertise transfer, and explores difficulties associated with expert self-reporting of complex tasks, the reasons those who have mastered teaching are often least likely to be able to analyze their cognitive processes and why experts fail to communicate the cognitive steps that compose their techniques. This section also reviews the impact of CTA on the elicitation of authentic expert processes. It is teachers doing things, practicing techniques, who experience CL, and so the literature review considers ways CTA classifies and categorizes practices that represent the recurrent performances of teachers in the classroom. Schematic decomposition, development of skills hierarchies, categorization of task types, and other essential elements of CTA foreshadow the inductive research approach and facilitate the elicitation of novice and expert knowledge and subjective experience through observation and interviews. Existing knowledge of cognitive psychology and CLT informed the relative inquiry and helped in the collection of data, the coding and the analysis of the phenomena of CL and the teacher learning designs that mitigate or contribute to short-term memory workload. This section will also look at the measurement of CL and its use in developing teacher flow and automaticity.

Psychological theories attempt to explain behavioral phenomena. CLT is based on the study of learning results under different conditions (Moreno & Park, 2010). While the idea of mental load was not new when the theory was developed, it was Sweller (1999) who incorporated early work in cognitive psychology in the areas of schema development (Anderson, 1983), dual-coding theory (Paivio, 1986) and the development of models of working memory (Baddeley, 1986). CLT (Paas, Tuovinen, Tabbers, & van Gerven, 2003; Sweller, van Merriënboer & Paas, 2011) begins by taking into account the restrictions and capacities in human cognitive architecture. When any complex tasks are learned, such as found in classroom teaching, psychological and behavioral phenomena result that are relevant to designing instruction for those complex tasks. CLT advances explanations for how instructional design impacts both learning and CL, relating these psychological constructs to learning results.

Cognitive architecture. CLT proposes a cognitive architecture that consists, first, of working memory that has a limited capacity (4 ± 1 elements of information) (Baddeley, 1986; Cowan, 2001; Miller, 1956) and a limited duration of around 30 seconds when working with new information (Cowan, 1988; Peterson & Peterson, 1959). Working memory, as defined by Baddeley (1992) is a segment of the brain that offers provisional storage that handles information required for complex cognitive tasks such as comprehending language, acquiring new information and reasoning (Baddeley, 1992). The limitations of working memory, a space of thinking that holds limited information, is very relevant for instructional design since the more information contained, the less room there is for mental processing. When overwhelmed with information, this processing, and therefore learning, also cease (Reid, 2008).

Long-term memory, on the other hand, has a capacity that is not limited (Sweller, 1994). CLT proposes that short-term or working memory processes bring together, or chunk information elements together to form schemas or constructs in long-term memory. Working memory can utilize a schema from long-term memory as though it is a single element, although it is in fact composed of many constituent parts (Pass, Renkl, & Sweller, 2003; Sweller, Ayres, & Kalyuga, 2011).

Within schemas of long-term memory learners integrate the steps of processing into a unity, so that, when problem-solving, a working memory may draw from long-term memory a group of elements as a single chunk, and work with it as if it were one item (Sweller, 1994). The execution is automated, or considered automatic, because the unit of information worked with is several elements, although it appears simple. When the limited capacity of working memory is optimized, schemas may be created and adapted and applied to problems that would be too complex to deal with by our more proximate working memory. A teacher with more automated tasks will have more space in working memory when practicing those skills than a teacher performing the same skills entirely within working memory. The latter teacher must concentrate on each step, while the former teacher has combined all of the steps into a single item that may be performed without conscious effort. The more developed long-term memory schemas become, the less CL is experienced.

CLT considers all effective instruction as the alteration of long-term memory. If learning does not impact long-term memory, then no learning has occurred. Instructional designs that powerfully shape long-term memory are effective, and those designs that do not alter long-term memory are likely to prove ineffective (Kirschner, Sweller, & Clark, 2006). CLT, therefore, identifies principles of instructional design that best support the most effective interaction of working memory and long-term memory in the acquisition of complex learning.

CLT explains why some information or skills are harder to learn. CLT serves as a theoretical framework for the design of optimal instruction, the movement of complex information and processes from short-term working memory into schemas within long-term memory. With it, leaders may plan instruction for novice teacher in the classroom with the goal of moving working memory in such a way as to have the greatest impact on long-term memory. It attempts to manage the capacities of processing (or CL) in such a way that the solution of problems or the inclusion of new understandings or techniques or tasks may be acquired as a schema and automated.

Types and dimensions of cognitive load. CL may be described as the number of non-automated responses required to solve a particular problem (Salomon, 1984). A novice, a teacher who has not yet automated or chunked certain tasks in long-term memory, must perform each step of solving a problem in working memory, and the solution does not come instantly. The less automated the processes, the greater the CL. Teacher expertise here is not defined by the number of years a teacher has served, but by the higher level of automated responses in recurrent practices which make for low levels of CL.

In the early years of CLT development, researchers identified three types of load, each of which consumes working memory space (Gerjets, Scheiter, & Catrambone, 2004; Kester, Kirschner, & van Merriënboer, 2005; Ngu, Mit, Shahbodin, & Tuovinen, 2009; Sweller, 2004; van Merriënboer & Sweller, 2005; Verhoeven, Schnotz, & Paas, 2009). Intrinsic load is the type of load directly applied by the material with which one is interacting. If a teacher is practicing the technique of circulating, of moving through the classroom in order to keep students on task and be available, that physical enactment, distinguished from all of the other simultaneous activities and communications of the teacher while performing it, represents a specific intrinsic load. An expert teacher will circulate without thinking and unconsciously pick up signals of where to move, even as their working memory is engaged in other processes; a novice will recognize the need to move, decide on a low-profile rate to walk to another row of desks, think about squaring the shoulders, then scan the class for the next movement. The person performing a cognitive task cannot immediately change that task's intrinsic load. Intrinsic load is not impacted by the design of instruction because it is a product both of learner characteristics (e.g., degree of automation), and this is the actual complexity of the task or technique or material to be learned (Sweller & Chandler, 1994).

Intrinsic CL will change as materials or information for learning differ in complexity and element interaction. As working memory commits complex tasks to long-term memory, the intrinsic load, the mental effort required of working memory to perform the task, will decrease. In other words, when an expert teacher performs a low-profile intervention, redirecting a student with a physical gesture, while simultaneously delivering a lecture, she might not even be aware that she did this task because the task is automated. In contrast, a novice teacher performing the same task might have to stop talking for a moment, consider appropriate responses, choose a physical gesture or signal from among many while reminding herself not to be too overt in sending it, execute the signal, evaluate the students' responses, and then continue the lecture after the sudden pause. Each step of the process that is not part of a schema, which is not automated, serves to increase the load of the complex task of redirection.

Complex tasks involve multiple steps and interacting elements. CLT learning design posits that when one omits some interacting elements or reduces the complexity of tasks, the focus is a delimited intrinsic load, a load that is more manageable. In the case given above, a teacher who is not circulating while doing a low-profile redirection processes less information. Training design for this teacher in low-profile redirections might begin without circulating, but just having teachers work different signals and movements to change student behaviors.

The learner is helped to build schemas by excluding other kinds of processing that might hinder working memory, or by focusing on specific tasks. Extraneous or inefficient CL refers to unnecessary information and processing during learning and the irrelevant activities required of learners that impose more effort and hinder schema acquisition. Unnecessary processing, or load that interferes with learning, or the kind of load that makes working memory use resources for activity irrelevant to schema acquisition or automation, is extraneous. To determine with a novice the level of extraneous CL, one would have to ask about a particular technique they were deliberately practicing (with its own intrinsic load) and what kept them from acquiring it. One might ask how they were distracted in their practice of this singular technique by other issues, needs or goals that presented in the classroom, or whether or not the technique was badly explained, or if the explanation or model left out necessary steps. The process would be one of identifying how the working memory's efforts in learning a task were increased by elements unrelated to the intrinsic load of the specific task.

Germane or efficient load refers to those learning activities that are relevant to schema acquisition and automation. Germane load occurs when a learner can construct, manage and automate schemas in an optimal setting and design. When learning is designed to direct attention to learning processes that are relevant, the load is germane and effective. Leppink and van Merriënboer (2015) cite sources of a reconceptualization of the three-category model and reduce the framework to extrinsic and intrinsic loads. A new conception of germane CL identifies it as the capacities of short-term memory allotted to working with intrinsic load (Kalyuga, 2011; Sweller, 2010; Sweller, Ayres, & Kalyuga, 2011). In the area of CL measurement, the emphasis has shifted exclusively to distinguishing between intrinsic and extraneous load, as will be discussed below in the review of measurement research (Leppink & van Merriënboer, 2015).

It becomes necessary to identify the types of load a teacher experiences, intrinsic or extraneous, in order to understand what is overwhelming that teacher. The amount of things happening in a classroom (extraneous, inefficient load) may overwhelm a teacher who is at a level of learning that makes it a struggle to focus on one thing (intrinsic load), and who cannot process the group of activities that will navigate more complex situations efficiently (germane load). CL represents a constantly fluctuating volume of mental steps of various kinds, the type of which determines either negative or positive results in expertise transfer. When teachers experience constant overload, learning stops, and the development of teacher expertise is frustrated. Due to the inherent complexity of teaching, CL for novice teachers is a cause for feelings of being overwhelmed (e.g., Carre, 1993, Kagan, 1992; Wideen et al. 1998), and for experiences of helplessness, frustration and anger (Hargreaves, 2005; Kelchtermans, 2005; Moos & Pitton, 2014; Olsen, 2010; van Veen & Lasky, 2005). Elevated levels of CL prohibit the transfer of expertise to new teachers (Clark, Feldon, van Merriënboer, Yates, & Early, 2008; Feldon, 2007a). Feelings of being overwhelmed and debilitating levels of CL, from the perspective of CL theorists, are signs of inadequate preservice training design (Kirschner, Sweller, & Clark, 2006; Moos & Pitton, 2014;

Sweller & Chandler, 1991; Vogel-Walcutt, 2011). Such higher levels of CL, therefore, are relevant and decisive when educators of teachers are designing learning for the transfer of expertise (Vogel-Walcutt, Gebrim, Bowers, Carper, & Nicholson, 2011). For these reasons, there is a need to design tools and techniques that meaningfully measure CL for the development of new teacher training strategies (Brünken, Seufert, & Paas, 2010; Feldon, 2007a; Moos & Pitton, 2014). Techniques that evaluate novice teacher CL will have the potential to assist teacher trainers in assessing forms of cognitive support, will help novice teachers in analyzing their decision-making processes, and focus novice teachers on essential elements of expert performance. For teacher trainers, a greater understanding and sensitivity to the phenomena of teacher CL will facilitate the refinement of learning designs that embed endemic skills to the level of automaticity. (Crandall, Klein, & Hoffman, 2006)

Some teacher attrition in the early years of teaching might be the result of frustrations associated with poor classroom teacher training design and higher levels of extraneous load. Since all three types of load are additive, all consume memory and working resources and can cause overload (Kirschner et al., 2009; Paas, Tuovinen, van Merriënboer, & Darabi, 2005). But the goals of learning design are to optimize intrinsic load by choosing tasks for learning that are in accord with a learner's prior knowledge (Kalyuga, 2009), to decrease extraneous load, and to engage learners in germane load according to specific design guidelines (Merriënboer & Sweller, 2009).

CLT describes the relationships between psychological constructs, traits or abilities that occur in human cognition (Moreno & Park, 2010), and presents possible explanations for teacher classroom behaviors. For example, according to CLT, a teacher can deal effectively with complicated classroom difficulties and gain very complex knowledge and skills because her short-term and limited working memory can cooperate with an unlimited long-term memory. She can incorporate complex, immediate tasks into her practice, and form efficient habits through a well-designed interaction of short-term and long-term memory. Another teacher may have to move step-by-step through a task that experts would consider easy, because the information has not yet been built into a long-term memory schema.

Automaticity and flow. The goal of all learning is to increase what working memory can do with the aggregations or chunks and schemas within long-term memory. When new information is acquired, it must be transferred from long-term memory to working memory, and from working to long-term, in order to build connections and integrate it. Developed schemas do not merely store or organize information in long-term memory, but they diminish working load since working memory can draw massive amounts of information as a single element with less effort (Sweller, van Merriënboer, & Paas, 1998). The teacher who is effortlessly handling several complex tasks at once even as she acquires new information is therefore not “a natural” or magical or even a genius. This teacher has integrated the processes and the knowledge into schemas and can perform three or four of these at once during complex classroom events and interaction with new information.

CLT can be utilized to advance teacher education by providing a framework for understanding how to integrate simple tasks into these larger schemas in a way that elevates automaticity and decreases mental effort for other tasks. For example, Sabers, Cushing and Berliner (1991) explored novice and expert teacher responses to classroom situations presented in videos to make determinations about teacher expertise. While novices focused on behavioral events, experienced teachers took a diverse set of classroom cues and integrated the information. Expert teachers demonstrated greater automaticity, and they could take in and interpret more information because of the effective acquisition of supportive schemas.

Instruction and classroom management in the expert teacher are performed simultaneously and do not overload their working memory. However, novices struggle with splitting attention between sources of information and diverse stimuli. What researchers describe as the split-attention effect is a lack of ability to split the attention or to perform acts simultaneously, where working memory is overloaded resulting in diminished performance (Sweller, 1994; Sweller & Chandler, 1991). However, while research indicates that classrooms and teachers could use the findings of cognitive psychology in the area of teacher automaticity, teacher preparation programs rarely do, a surprising fact since research examined through the lens of cognitive psychology emphasizes that developing automaticity will increase teacher effectiveness and decrease teacher stress (Feldon, 2007a).

Expert knowledge and the need for CTA. CLT belongs to the specific research regarding expertise transfer and CL is a phenomenon that specifically belongs to learning design. The transfer of expert skills, abilities and techniques involves experts in a process with classroom teachers and students that may be frustrating and that may overwhelm a novice teacher. Novice teachers must bear the weight of many techniques and skills in working memory, often without weight-lifting training. The theoretical framework of CLT enhances sensitivity to novice experiences while the techniques of CTA inform the inductive inquiry and help validate observation and interview data, locating experiences within the context of complex learning design for the classroom. Research literature that decomposes the most basic teachers' practice into tasks, goals and complex skills illuminates whether teacher learning is effectively structured to support recurrent cognitive processes and to solve endemic classroom problems. The research literature offers two pillars of novice teacher support that include a learning design informed by CTA and also the recurrent techniques mastered and automated by expert teachers. Reference to these ways of looking at teacher practice will focus observations and interviews of expert coaches and novice teachers.

CL is the result of a specific quantity of non-automated, non-schematized procedures, and similar procedures have already been subject to analysis by CL theorists and psychologists, who utilize CTA to categorize these. To properly observe and interview teachers regarding their experience of CL, it is necessary to identify and analyze the specific tasks and techniques of effective teaching within the complex classroom environment, and requires reference to CTA. Expert teachers support novices with either effective or flawed task descriptions of the art of teaching, and this impacts novice performance and learning. Descriptions of teaching performance take many forms and offer multiple definitions, many of them flawed, as will be discussed below, and the manner of analysis utilized to explore novice and expert teacher practice will assist in the exploration of the phenomena of teacher mental effort.

An expert's long-term memory contains large schemas consisting of many unconscious, automatic behaviors, and researchers can label these professional practices. But how experts themselves represent a complex task may be confusing. An expert will likely leave unmentioned many parts of a task and its constituent subtasks, elements he or she may not recognize because these are no longer a part of working memory and have been automatized. Without analysis of a comprehensive expert schema, one would be challenged to distinguish intrinsic from extrinsic loads being experienced by teachers with accuracy. Novice teachers might assume knowledge of a schema without having acquired real components of a specific complex task. CTA is a family of techniques that identify expert knowledge and analyze components of expert practice. CTA procedures and approaches will form a framework for observing and interviewing teachers and coaches about their own practice and their inner experience as it relates to specific types of actions and cognitive processes (Crandall, Kein, & Hoffman, 2006).

Expert self-reporting. The role of experts in coaching and in developing training are diverse, and involve identification of the skills and techniques that novices must acquire and ways that learners may solve problems. However, research on expertise has found that experts are often imprecise and wrong when they describe the ways that they make complex decisions (Feldon, 2007b). In their explanations of decisions and judgments within complex tasks, procedural descriptions of experts are often flawed, especially since automation of the steps in a decision make the steps seem to blend (Sullivan et al., 2008).

Expert teachers who have automated many tasks, integrating them as schemas in long-term memory, perform constituent elements of complex tasks without being consciously aware of the entire cognitive process. The many elements of techniques may seem entirely singular, having become a chunk or schema of long-term memory (Clark & Estes, 1996). Findings of CL researchers regarding expert self-reporting seems counterintuitive. Frequently practiced cognitive processes demand less and less mental effort until they may be performed unconsciously or automatically (Anderson, 1982; Moors & De Houwer, 2006).

For such experts, problem-solving challenges that are fundamental to expertise do not occupy the resources of working memory. Steps go unnoticed. Their ability to report the elements that make up their expertise, the distinct steps they, in fact, take toward solutions to problems, is limited. The same processes that increase performance, moving complex tasks from working to long-term memory, also make it difficult for experts to express the steps and that make them successful.

Expert self-reporting regarding their practice and what makes them successful is often inaccurate. Attention to the parts of what experts are doing occurs preconsciously. For example, expert teachers often make what seem to be intuitive leaps in diagnosing student thinking, and cannot describe the basis for their responsiveness to or discounting of explicit student cues in the classroom. These teachers have schemas that cause them to over-simplify explanations or remove parts from descriptions and make elements that are redundant less likely to be recognized (Feldon & Stowe, 2009). Expert cognition is hindered by two mechanisms. First, because they develop very complex schemas within their domain, they can solve remarkably complex problems without effort, going through the steps of the process in what, to them, seems to be a single step. The cost of automating skills is not being able to break down the schema or explain the interactivity of elements.

The expert automation of tasks prevents or distorts conscious monitoring of their own procedures in their domain, as they solve problems without conscious effort (Feldon, Timmerman, Stowe, & Showman, 2010). Experts have difficulty n translating their professional habits into practical instruction because they are not conscious of their actions. Therefore specific skills that represent expertise, having been practiced to fluidity and automaticity become difficult to analyze for experts, who struggle to decompose the processes that lead to success into a declarative knowledge. (Feldon, 2010) The most frequent and endemic mental processes become automated, and experts are not consciously aware of these (Moors & De Houwer, 2006).

In one experiment, expert psychologists incorrectly described or left out an average of 75% of the steps that were both used to create experiments and to review the data that resulted (Feldon, 2010). Feldon (2010) cites other studies with similar results. CL theorists also posit the expertise reversal effect in learning, where experts come to see the most recurrent steps of their practice as redundant, having automatized most of them (Rey & Fischer, 2012; Roelle & Berthold, 2013). This effect leads to indifference regarding the exact steps to decision-making and problem-solving processes. Applied to teaching, how might this difficulty become problematic? America has a massive body of expert teachers and research on teaching, but we also have a huge novice teacher attrition rate; the attrition rate may not be the result of a lack of expertise on the part of coaches, but may instead be the result of a lack of tools for eliciting from those experts the most fundamental elements of practice that contribute to true expertise. Putting expert teachers in charge of novices may be the problem. Many of those who develop and teach education theory fail to notice the most useful techniques of expert teachers (Lemov, 2016). Difficulties that cognitive psychologists describe in expert self-reporting may well lead to the blind spot to which Lemov refers. There is a documented disconnect between expert descriptions of their own practice and the procedures they utilize in authentic environments (Tofel-Grehl & Feldon, 2013).

The automaticity and schema development that constitute expertise also make an expert lean toward ignorance and indifference in regards to learning the most supportive subtasks within their domains (Feldon, 2010). If experts are instructing our teachers, developing assessments of their performance or observation protocols, the limitations of expert self-reporting will impact teacher instruction, especially if the core elements of teaching processes are not perceived or left out. Gaps in guidance have been shown to contribute to greater levels of CL in learners (Chandler & Sweller, 1991; Kirschner, Sweller, & Clark, 2006; Sweller, Chandler, Tierney, & Cooper, 1990; Tuovinen & Sweller, 1999).

When novices have gaps in processes and the steps of recurrent or endemic problems are left out, this void in information will generate extraneous CL. Preservice teachers may attempt to fill the gaps while learning on-the-go, within the complex environment that is the classroom, leading to poor problem-solving and decreased performance (Tofel-Grehl & Feldon, 2013). In other words, when an expert teacher describes their own expert practice according to what is at the forefront of their own expert working memory, offering a kind of gold standard practice, that expert most likely will ignore the automated processes that support that practice. These experts are most likely not accessing the automated processes or practices that truly support the gold standard practices, and the novice being shown the expert gold standard must not only practice the complex item that represents the standard, but must magically come up with the ten other items that support that standard and have gone unreported. These latter items might be described as natural or obvious or the result of basic experience; the novice will be expected to just "get it". What is extraneous CL in this situation is an omission of the practices, subtasks, that when performed with automaticity in the complex classroom, allow a teacher to simultaneously perform the gold standard practice. It is not the lack of expertise that kills novice training, but the refinement of it and the lack of consciousness regarding practice that results. These difficulties with expert self-reporting may be an explanation for the deficiencies in university education programs. The very expertise that qualifies people to become teachers of teachers makes it difficult for experts to decode the tasks of teachings, which makes it necessary for those trained in CTA to go back to the classroom and observe and analyze actual expert performance.

Cognitive task analysis. CTA is a wide variety of methods and guidance in probing cognitive processes, and is used to determine the cognitive skills, strategies and the knowledge that are required to perform tasks (Essens et al., 1995; Godon, 1994; Hoffman & Militellow, 2014; Redding, 1989; Roth, Woods, & Pople, 1992). A phenomenological study of CL that includes probes of cognitive processes and that evaluates the cognitive skills, strategies and knowledge of novice teachers will therefore demand CTA. According to Hoffman and Militello (2014), "nearly all research in the area of Expertise Studies involves CTA, with the emphasis on cognitive, that is, research to reveal and explore the phenomena of cognition" (p. 130). CL is a phenomenon of cognition. CTA overcomes the challenge of cognitive process articulation associated with load. It is used to elicit expert knowledge and utilize this knowledge for expertise transfer. How is the study of these tools relevant to an inductive study of novice teachers and their expert coaches? In order to understand CL in real-life classroom ecologies, one must be able to describe the processes, goals, and tasks of teaching, and evaluate what novice teachers are doing in the context of expertise transfer. CTA is a group of techniques that draw more exact descriptions of complex processes from experts (Feldon, Timmerman, Stowe, & Showman, 2010). Research on the use of CTA techniques for instructional development has demonstrated higher learning outcomes compared to traditional instructional techniques (Clark, Feldon, van Merrienboer, Yates, & Early, 2008; Feldon & Stowe, 2009). The majority of knowledge analysts follow a five-stage process, in this sequence: (a) collect preliminary knowledge, (b) identify knowledge representations, (c) apply focused knowledge elicitation methods, (d) analyze and verify data acquired, and (e) format results for the intended application (Clark, Feldon, van Merriënboer, Yates, & Early, 2008).

Collecting preliminary knowledge orients researchers to the knowledge domain, the authentic, real-life processes and tasks of experts. Collection of knowledge representations is a stage of CTA that includes identifying subtasks and the forms of knowledge needed to perform them, thus decomposing a complex task into its components. As they elicit knowledge from experts, researchers apply methods that combine interviews, direct observations, and simulations of the tasks from multiple experts, whose accounts are synthesized as processes emerge. Analysis and data verification confirm the data received from the elicitation and the results of the former synthesis are formatted for the application, described as action steps or rules for decisions that will solve a class of realworld problems (Feldon, Timmerman, Stowe & Showman, 2010). The result is a set of protocols with useful steps and relevant cues that guide decisions.

The result of studying expertise has been the classification of different categories of tasks within the real world. Researchers distinguish real-life tasks from those that are often found in traditional education and training. Problems in traditional learning settings are limited to subject-specific domains, are well-structured, and have a limited number of difficulties and solutions. In contrast, real-life tasks may be characterized as ill-defined and move beyond established areas of practice. Real-life tasks have multiple dimensions and the domains in which they are performed have unclear goals and offer incomplete information. There are no right or wrong answers but a large group of responses that are more or less adequate. These problems cannot be adequately described nor resolved with a complete, expert solution, and experts will not agree on the answers.

Real-life tasks contain many complications and learners are often dependent on a team to develop a solution. For those who design learning based on CTA, real-life tasks are the foundation of learning tasks and whole-task practice. The result of CTA, an understanding of the constituent elements of real-life tasks, allows learners to confront the actual elements of any complex task such as teaching. The techniques used by cognitive task analysts in designing instruction are made to meet the challenge of real-life complexity. Knowledge, skills, and attitudes are brought together in engaging tasks that constitute skills in a way that is not possible merely studying abstract information. The learner is made to focus on the cognitive processes for learning and not merely on precise execution of tasks. (van Merriënboer & Kirschner, 2013)

When characterizing complex learning and expert task performance, analysts draw significant qualitative distinctions between types of integral skills. A complex task, such as redirecting students while offering support during a reading assignment, will involve different tasks along a skills hierarchy. The teacher is giving information and instructions, eliciting student information and simultaneously must keep students from a side-conversation without distracting the entire class or breaking up the flow. Some constituent skills that will navigate this complex problem are rule-based and highly routine, and the response is consistent from challenge to challenge. Experts perform these recurrent tasks almost without thinking in well-formed cognitive and psychomotor responses. These tasks are rule-bound, and difficult to articulate, for these are done without a lot of conscious control. The expert can focus attention elsewhere while performing these tasks, simultaneously applying creative energy and nonrecurrent skills elsewhere.

Nonrecurrent and recurrent skills are qualitatively different both in the way they are practiced and the way they are learned. Nonrecurrent constituent skills are constructed as schemas, abstracting information from details and working from models that apply to many different situations; these are learned in processes that involve variability of problem-solving in authentic environments, where automaticity is more of a hindrance to developing creative solutions. Recurrent constituent skills are performed as rule-based processes. Recurrent skills are learned by repetition and drill, where automaticity is valued and serves to support nonrecurrent skills. (van Merriënboer & Kirschner, 2013)

Well-developed recurrent skills support the development of skills that are nonrecurrent. In other words, the teacher whose working memory is not occupied with very predictable and recurring items of teaching, is able to utilize that working memory space to focus on nonrecurrent items. She is able to redirect students during a reading assignment, a common occurrence, while at the same time helping a struggling student, by sending low-profile physical signal to distracted students (recurrent skill) to put them back on task. At the same time this redirection must happen, the teacher may also be trying to determine whether the struggling student is having decoding or comprehension problems (nonrecurrent skill). The former, automatically performed task supports the latter task of diagnosing an individual student's difficulty.

The objectives of a task are classified as nonrecurrent if responses and interactions vary from problem to problem, and are guided by variable cognitive strategies. These tasks may be characterized as exotic, or answering less predictable situations. The objectives are classified as recurrent if the response to particular problems is similar, guided by set procedures (Clark, Feldon, van Merriënboer, Yates, & Early, 2008). Recurrent tasks may be characterized as endemic.

Since recurrent skills can be trained and practiced to a high level of automaticity, such skills may support the more creative, nonrecurrent tasks in working memory. If one were to decompose an effective teacher's practice, one might find that the teacher who is most creative in application of nonrecurrent learning tasks is also the teacher who is able to perform recurrent classroom management tasks without thinking about these. The recurrent aspects of classroom practice are so automatic that the teacher has freed working memory space for higher order cognitive work and creative practice.

However, such expertise may lead to a quandary in the training of novice teachers, as described above. The expert is often unaware of or uninterested in the recurrent, endemic, mundane practices that are automatized. When a task becomes a schema in long-term memory it will appear in working memory in a simplified form, as a single unit of information. Experts are no longer aware of the many steps that are part of a complex task, and the focus of their practice is the nonrecurrent aspects of complex skills. Hence the expert teacher, in a training session with a novice, might focus more on the exotic, the nonrecurrent parts of teaching that most occupy his or her working memory during the day. Although the supportive, recurrent parts of teaching are still active in the practice of the expert, these tasks remain largely ignored, even though these make possible the nonrecurrent aspects of teaching, and are the real source of the expert's success.

The real-life tasks of the complex classroom environment demand of the novice both recurrent (supportive) and nonrecurrent tasks that often must be performed simultaneously and with a high degree of automaticity. However, CL increases as novice teachers try to put into practice the nonrecurrent and exotic techniques demanded of them. Although novices should develop a robust basic knowledge of the recurrent aspects to support the nonrecurrent, those recurrent helps become merely extraneous sources of CL as they focus on the more exotic tasks. The novice teacher in this scenario will most likely fail the so-called expert and not fulfill his or her view of teaching, and will also fail to learn both recurrent and nonrecurrent aspects of teaching. The preservice teacher may watch the expert move through complex classroom tasks seamlessly, but be unable to repeat the performance, not having been given the real tools.

This research is important for a phenomenological study of CL. An observer and an interviewer of teachers and coaches must be able to distinguish types of load that a teacher is experiencing. Only by identifying and distinguishing intrinsic loads, loads relevant to the immediate goals and needs of novice learning, from extraneous loads, or loads that result from flawed expert reporting, will the observer be able to adequately listen to and analyze the story that the novice teacher or the expert coach is telling. Germane loads, cognitive processes that assist learning, may only come to light with the tools of CTA. Studying learning designs based on CTA can give us points of references for analyzing different types of CL in a phenomenological analysis, by allowing us to clear the ground on flawed forms of learning design.

CTA draws out and utilizes unconscious expert knowledge to create training designs and align learning objectives and knowledge with instructional methods. Real transfer of expertise begins with such analysis, to bring to light what the expert is doing unconsciously, and offer that supportive information to novices. Among the methods used to align knowledge with instruction, the most completely developed is the Four Component Instructional Design (4C/ID) model (Clark, Feldon, van Merrienboer, Yates, & Early, 2008; van Merriënboer, Clark, & de Croock, 2002; van Merriënboer & Kirschner, 2013). Once the elements of expertise, the constituent steps of complex tasks, are analyzed, then complex skills are taught in supportive environments. The four components characterize the learning, parts of which interact with each other.

The first component of complex learning design is the concept of learning tasks. Learning tasks in authentic environments are ordered from easy to difficult, or simple-to-complex, are concrete, authentic experiences. Analysts organize learning tasks that are similar in difficulty as a task class, or as information or processes that utilize the same area of knowledge. Trainers support Initial learning tasks to facilitate schema development so that the learner automates recurrent processes, and frees working memory for nonrecurrent tasks. The second component of complex learning design, supportive information, is organized by task class and is consistently given to the learner for nonrecurrent parts of learning tasks. It consists of modeling, examples and feedback, all of which help with learner interpretation of cues, reasoning processes and the activities associated with problem-solving. The supportive information allows learners to elaborate and build on prior knowledge as they utilize new learning. A third component, Just-in-time, or procedural information, applies to routine or recurrent parts of the task to be learned and is comprised of rules, processes, explanations and feedback given in small units. Trainers offer definitions, examples and illustrations of concepts until a task becomes automatic and the amount of just-in-time information decreases. Lastly, part-task practice also applies to recurrent aspects of skills when the learner requires greater automaticity, wherein complex tasks are organized into discrete parts to focus learning. (Clark, Feldon, van Merrienboer, Yates, & Early, 2008; van Merriënboer & Kirschner, 2013).

The Four Component Instructional Design (4C/ID) makes use of these four components to design learning. While there are many families and techniques of CTA, 4C/ID makes use of these components to within four tasks that are unique to the 4C/ID model. First, 4C/ID decomposes complex skills into skill hierarchies. For example, analysts specify objectives of tasks as coordinate (performed in temporal order, simultaneous (performed concurrently), and transposable (performed in any order), and also as recurrent or nonrecurrent. This decomposition takes place through observation, interviews of experts and analysis of documentation for information. Decomposition is used to develop the hierarchy of skills in a given task, and subsequently verified (Clark, Feldon, van Merrienboer, Yates, & Early, 2008). 4C/ID CTA also develops categories for learning tasks and organizes them into classes, from simple to complex. The goal is to create a whole-task approach that is supported by a simple-to-complex organization in order to optimize learning (van Merriënboer & Kirschner, 2013). A third collection of analytical tasks involves an analysis of the nonrecurrent aspects of the complex skill in order to create mental models and strategies for complex tasks, moving from simple and complex versions to capture how experts face the particular challenge (Clark, et al., 2008). The last group of analysis activities is the analysis of recurrent parts of the complex skill. Lowest levels of expert ability and its components are identified and the automated skills are aligned in the skills hierarchy to support the nonrecurrent skills (van Merriënboer, Clark, & de Croock, 2002; van Merriënboer & Kirschner, 2013).

Cognitive psychologists utilize CTA to develop skills hierarchies and categorize elements of expert practice. CTA and the instructional design that follows provide a framework for understanding how a teacher might be unraveled in the real-life situation of the classroom (van Merriënboer & Kirschner, 2013), and clarifies differences in the types of tasks involved in teaching. One type of simpler task supports the practice and acquisition of another, more complex task, and CTA offers tools for analyzing and sequencing items of teaching. When these tasks are not ordered correctly in teacher professional development, the result is frustration. A good question to a frustrated teacher might be: what other practices, once automated, would support the activity you are finding difficult? The tools of CTA may be used to develop questions that evaluate CL in specific items of classroom teaching.

This literature review sets some underlying assumptions for this dissertation study, based on the framework of CTA, which may be summarized as follows. Items of teaching exist along a skills hierarchy. Techniques of CTA may be used to identify where specific teaching skills are within that hierarchy, and their degree of simplicity or complexity. Teacher skills within the hierarchy also categorize into task classes such as recurrent and nonrecurrent. These categories are factors in teacher effectiveness and their experience of CL.

Developments in the measurement of cognitive load. This study assumes that teachers are able to assess their own mental workload as they perform tasks. This research represents a change in approach for tools and systems designed to impact teacher development. It shifts focus to the subjective experience of novice teachers undergoing different, sometimes debilitating levels of CL, and on the ways that experts directing teacher instruction might respond to various types and levels of CL. Nationally, reports have acknowledged the inaccuracy of teacher evaluation systems, their failure to distinguish effective from ineffective teaching, and lamented that these systems have not aided education leaders in developing teacher expertise (Bill and Melinda Gates Foundation, 2011; Toch & Rothman, 2008; U.S. Department of Education, 2009; Weisberg, Sexton, Mulhern, & Keeling, 2009). While there is a welcome shift in evaluation systems from tools that measure teacher competence to those that supportively focus on teacher development (Marzano, 2012), there is also need for a paradigm change in the goals of teacher development tools. The subjective experiences of an individual teacher are relevant for learning design. CLT has been utilized and proven successful for expertise transfer in other fields (Feldon, 2007a; Jipp, 2016; Paas & Kester, 2006; Qiao et al., 2014; Remy, Rikers, van Gerven & Schmidt, 2004; van Merriënboer & Sweller 2010; Vogel-Walcutt, Gebrim, Bowers, Carper, & Nicholson, 2011). CLT may be utilized for the highly complex cognitive tasks of teacher experts and novices in the same way it is used in medical, industrial, military and government education for complex tasks, although the research indicates a lack of formal development of this type of instruction in teacher training (Feldon, 2007a; Kagan, 1992). However, in light of how measures of CL are used in other areas of expertise transfer (Brünken, Seufert, & Paas, 2010), attention to the phenomena of teacher CL opens new possibilities for teacher development.

The researcher in the current study assumes that CL is a phenomenon that may be evaluated or measured, that teachers may self-report their levels of mental workload. While understanding cognitive processes of teachers is important, education leaders must also address how we measure the critical elements within teacher learning processes (Cochran-Smith, 2003; Darling-Hammond & Bransford, 2005). Situated within the complex ecology of the classroom, teachers perform real-life tasks, tasks that are incomplete and lack simple outcomes, as described above. Although advances education leaders have made in subjective assessments of teacher learning have been many, assessments that take into account the complexity of the classroom environment have been few (Kersting, 2008). How an observer might measure CL levels during practice in the complex classroom must be considered because research in this area could provide a formative perspective of learning process efficiency, could identify areas of teacher need, and could also help researchers gauge the effectiveness of different methodologies for approaching items of teaching (Remy, Rikers, Pascal, van Gerven, & Schmidt, 2004). Literature regarding CL measurement attempts to answer questions concerning the phenomena of CL and how teachers subjectively evaluate their own experience.

Since the inception of CLT, researchers have attempted the measurements of CL. Researchers have utilized indirect measures, such as error rates, time on task and computational models, and also dual-task methodologies for measuring working memory load (Sweller, Ayres, & Kalyuga, 2011). Many researchers have been favorable toward the self-rating instrument developed by Paas (1992; Paas, Tuovinen, Tabbers, & van Gerven, 2003; van Gog & Paas, 2008). Reviews have considered it as a reliable and valid estimator of general mental effort, without reference to types of CL (Ayres, 2006; Paas, Ayres, & Pachman, 2008, Paas, et al., 2003; Paas, van Merriënboer, & Adam, 1994). Similar to a Likert scale, this measure asks learners to rate the amount of mental effort at different stages of learning on a nine-point scale, where 1 equals a "Very, very low mental effort" and 9 equals a "Very, very high mental effort." Whelan's (2006) research demonstrated the reliability and validity of this method, after comparing different measures of mental workload (SCL; the Task Complexity Index, Braarud, 2001; the Workload Profile Index, Tsang & Velazquez, 1996). This particular scale utilizes the term "mental effort," which may be defined as the capacity the learner has to deal with the cognitive challenges demanded by a task without reference to intrinsic or extraneous load types (Leppink & van Merriënboer, 2015, p. 233).

However, recent research indicates that such a measure of the overall CL has deficiencies and that it is important to identify the variables within a measurement. Overall load is considered the intrinsic and the extraneous CL taken together (Kalyuga, 2011; Sweller, 2010, Sweller, Ayres, & Kalyuga, 2011). Intrinsic load is a combination of task complexity and student (novice teacher) prior knowledge (Sweller, 1994). A more expert teacher could be assumed to have greater knowledge and could be expected to experience less intrinsic CL than a novice who is facing the same task. Extraneous CL results from giving the kind of information (e.g., coaching, explanation, and classroom situations to which a teacher must respond) which requires a student's mental processing in areas indirect to the learning or the performance at hand. It will be important to distinguish intrinsic from extraneous CL in any interview or observational protocol that focuses on teacher CL.

More recent research in the measurement of CL has shifted to instruments that distinguish between extraneous load and intrinsic load to identify the actual intrinsic load. Naismith, Cheung, Ringsted, and Cavalcanti (2015) demonstrated that intrinsic load is the most quantifiable, with good degrees of correlation between scoring systems. Extrinsic load and germane load are harder to measure in terms of validity. Leppink, Paas, van Gog, van der Vleuten, and van Merriënboer (2014) claimed that instances of measurement that attempt to measure extraneous or germane load may face a conceptual problem. Experienced learners will display levels of load and their impact on learning in a different way than novice learners. Load that a more novice learner would view as extraneous, or a hindrance to developing skills, might be seen as germane load, helpful to learning, by more experienced learners.

Recent studies of subjective measures of CL focus on multiple measures of the load. Leppink and van Merriënboer (2015a) explored inventories consisting of three or four statement items along with a scale for different loads for each category of load. Designed by Leppink and colleagues (Leppink, Paas, van der Vleuten, van Gog, & van Merriënboer, 2013; Leppink, Paas, van Gog, van der Vleuten, & van Merriënboer, 2014) have designed a multi-item questionnaire that improves on the design introduced by Paas (1992). Paas's single item mental effort scale does not distinguish between extrinsic and intrinsic loads. It measures CL as a whole.

The accurate measurement of CL necessitates a recognition of the different types of load. Although what a teacher may immediately experience is frustration or overload relating to a particular practice, both intrinsic and extraneous load factors may come into play. According to some researchers of CL measurement, it is impossible to distinguish between the two types of load in an inventory that considers CL as a simple experience; the only way to differentiate with such an inventory between extraneous and intrinsic load would be to keep one type of load constant in an experiment and to focus inventory questions on the other type. Changes in mental effort may be from the extraneous load and not intrinsic, and therefore data has the potential to become muddled. If a teacher during practice sees the need to give explicit instructions to students who are off task, and must, at the same time, also take attendance, the effort of redirecting students will become greater due to the extraneous attendance-taking. As a novice teacher's classroom interactions become more complex, such as when teachers exercise more significant amounts of simultaneity, the identification of extraneous factors becomes necessary in a research instrument. Distinguishing the two factors of intrinsic and extrinsic CL within an item measurement can capture whether the source of the load is the difficulty of the task as experienced by the learner (intrinsic) or confusion introduced by environmental factors or instructional design (extrinsic) (Leppink, et.al., 2014). The differentiation allows greater detail in determining learning levels. Leppink, van Gog, Paas, and Sweller (2015b, p. 213) presented a Likert scale to students who had completed a task, with questions that related to the complexity of the activity and questions that related to explanations and instruction of the activity, distinguishing the intrinsic and extrinsic elements of their load. The issue to be addressed with any form of measurement is how well one may validly and reliably measure load within the classroom tasks of novice teachers? How does a skills hierarchy that divides tasks into recurrent and nonrecurrent processes impact the framing of questions? If large schemas constitute the items, leaving out steps in more constituent processes, do the questions accurately describe items with intrinsic load? The level of abstraction within our labels of items may not fit the specific observable and experienced skill or technique, and care must be taken in item selection.

In selecting techniques and strategies of teaching to study, Kagan explained a problem called the “Goldilocks Principle.” Some concepts of teaching seem too small and some too large to be translated into manageable terms. The literature is ambiguous about teacher cognition in performing these items, because of a lack of definition of cognition itself and how it relates to teaching. (Kagan, 1990) How does the “Goldilocks Principle” impact the measurability of items and the ability to distinguish between what are extraneous sources of load and the intrinsic load of specific processes? These questions relate to the specific domain of skills, or to classroom complexity, and the classroom as a learning environment for improving teacher performance. The ambiguity of the ‘Goldilocks Principle’ that Kagan describes in teaching points to the need for the eidetic reduction of phenomenology. Any study of the phenomena of CL must take into account this complexity, which leads to the second section of this literature review.

Section Two: The Complexity of Teaching

In this second section, the review will consider the challenges of current teacher instruction, which includes studies of the characteristics of the classroom as a complex learning environment, research into the complexity of the teaching profession and the high demand for models of complex learning posed by the need for efficient instructional techniques. This portion of the review will also examine why the teaching profession has not utilized the resources of CLT and why teacher education has largely ignored the architecture of expert learning, and thus produced what Green (2014) calls a "culture of abandonment" (p. 15). Constructivist theories of professional development, which include minimal guidance, have dominated teacher preparation and have been identified as a flawed approach to novice teacher professional development. The researcher will also review the works of several researchers who have considered this problem and looked at classroom teaching through the lens of CLT, with their recommendations for future research.

The success of teachers is vital to our nation (Darling-Hammond & Bransford, 2005). The ways in which teachers become experts has been the subject of much research (Darling-Hammond, Hammerness, Grossman, Rust, & Schulman, 2005). Understanding how teachers develop knowledge and transfer expertise is vital for professional development and preservice training (Darling-Hammond, 2006; Darling-Hammond & Bransford, 2005). Theory-based university classes may not foster novice teacher development in classroom practice (Kennedy, Ahn, & Choi, 2008).

In trying to apply learning from theory-based settings to classroom practice, novice teachers experience a struggle to the point of being stunned by classroom complexity once in the environment (Cochran-Smith, 2003). Studies about how preservice teachers acquire new information, and the cognitive processes in which they engage during knowledge integration in universities are rare (Desimone, 2009; Zeichner, 2005). More effective teacher education programs would result from studying teacher cognitive processes (Zeichner, 2005).

Feldon (2007a) explores the dimensions of learning to teach as complex learning. When trainers leave novice teachers unguided in the complex classroom, left to deal with their high levels of CL, it produces teachers who are unable to learn and who struggle to function. Complexity is not the sole issue, but classroom complexity does impact the learning of novice teachers either positively or negatively. Some researchers have observed that basic pedagogical skills, classroom management issues, and curricular content impose nearly all the CL that novice teachers can process successfully (Swanson, O'Connor, & Cooney, 1990). According to Feldon (2007a), while novices may experience frustration as they enact specific tasks, expert teachers performing the same tasks have mapped their responses to student behaviors and acquired a high level of automaticity, a high reliability of response accompanied by less concentration. Experts dedicate simultaneous attention to both instruction and classroom management, so they address disruptive behaviors of students more successfully than do their novice colleagues (Swanson, O'Connor & Cooney, 1990). Endemic to classroom teaching are complex tasks that "have many different solutions, are ecologically valid, cannot be mastered in a single session and pose a very high load on the learner's cognitive system" (van Merriënboer, Kester, & Paas, 2006). Teacher cognition and the dual-process model of cognition are important for the framing of this research because one must measure the dynamic modulation between deliberate or conscious higher-order activity and automatic or nonconscious classroom habits.

The failure of trainers to transfer the cognitive tools and skills needed to novices is demonstrated by new teachers who struggle with behavior management in real classrooms (Smart & Igo, 2010). The skill of teaching is like a puzzle with constantly changing pieces in which veteran, expert teachers can organize incoming information and make what is complex seem simple. In their interactions with students, expert teachers routinize practices and can simplify activities during lessons, whereas novices, not having routines, are constantly changing their actions during lesson delivery and were unable to give attention to the accomplishment of goals. Research indicates that when teachers have problems with integrating the theoretical knowledge to classroom situations, they will draw from their beliefs and generate their own theories instead of basing practice on science or on factual evidence (Cochran-Smith, 2003; Lampert & Ball, 1998). Feldon (2007a) cites multiple studies on cognitive defaults in education, how CL forces teachers to substitute difficult techniques with easier practices; a teacher trained in an effective disciplinary technique might default to a more emotion-driven or authoritarian response under increased CL and may acquire inefficient strategies due to the prevalence of CL in problem-solving. Poor strategies or responses that are not research-based abound when teachers continually default to these due to overwhelming levels of CL. (Feldon, 2007a)

Constructivism. In the design of teacher preparation, CTA has not been applied in practice to a wide degree, possibly because the assumptions that underlie it are in conflict with constructivism and problem-based learning (Clark, Feldon, van Merrienboer, Yates, & Early, 2008; Kirschner, Sweller, & Clark, 2006). The theoretical framework utilized to help novice teachers navigate classroom complexity is relevant to the study of CL, because constructivism and problem-based learning will either contribute or not contribute to novice teacher support, and this theoretical framework currently dominates classroom teaching. Constructivist theory is the basis of much preservice teacher learning design and considers learning processes as the self-directed building of knowledge within a social setting (Bransford, Brown, & Cocking, 2000; Moreno & Park, 2010). This approach conceives teaching as the enactment of learning environments, the creation of occasions for the active and intentional engagement of learners in cognitive activities.

For constructivists, the role of teachers is to facilitate a cognitive process by motivating students and moving them forward (Seidel & Shevelson, 2007). One form of constructivist learning is discovery learning (Kirschner, Sweller, & Clark, 2006). Discovery learning provides learners with either the most thorough or the minimum guidance possible, but with an understanding that learning goals should be met independently, and with just the materials provided. In other words, the least possible assistance to the learners is provided based on the extent of difficulty met when trying to discover the knowledge, allowing the learners to construct new knowledge, as much as possible, on their own.

The research literature from cognitive psychologists indicates that minimal guidance of learners within a complex environment is detrimental to learning. CLT has explained why some of the most promoted constructivist tactics have failed. When learners are novices in a domain (such as teaching), unguided discovery generates a high level of CL; novice schemas are too under-developed to guide complex knowledge construction (Moreno & Park, 2010). CLT is about how cognitive resources are focused and applied to learning, and when cognitive activities are far removed from task goals, the resulting load impedes learning (Chandler & Sweller, 1991). Forms of teacher education derived from constructivism that place learners in complex environments and allow them to process and interact with information in their own way in order to derive meaning are counterproductive. This is because, for the novice teacher, the free explorations of complex classroom environments may overload the working memory and hurt learning (Paas, Renkl, & Sweller, 2003; Sweller, 1999, 2004). Unguided exploration of a complex learning environment may cause a larger CL and has been shown to decrease learning, compared to more focused worked-example practice (Tuovinen & Sweller, 1999).

Finding solutions to problems in discovery learning demands increased mental effort and requires one to sift through the space of working memory, which challenges the limited working-memory; according to CLT, this process is likely to prevent complex learning (Sweller, 1988; Rittle-Johnson, 2006). Learners also must be able to monitor the steps toward information in its proper context (Case, 1998; Kirschner, Sweller, & Clark, 2006), which requires metacognitive skills that learners may not possess (Dewey, 1910; Flavell, 2000; Kuhn & Dean, 2004). Discovery and constructivist learning requires more mental operations and steps than an approach that offers more directive forms of guidance. CLT indicates that complex learning domains impose heavy loads on working memory and that these loads make learning more difficult (Chandler & Sweller, 1991; Kirschner, Sweller, & Clark, 2006; Paas, Renkl, & Sweller, 2003; Sweller, 1988; 1994). Constructivist approaches to teacher preparation hinder the transfer of expertise in certain environments, and for learners with lower development.

Some constructivists do not advocate completely unaided learning (Hmelo-Silver, Duncan, & Chinn, 2007; Schmidt, Loyens, van Gog, & Paas, 2007; Spiro & DeSchryver, 2009). For some, an important part of constructivist learning design includes guidance (Tobias & Duffy, 2009). However, unassisted tasks remain a large part of constructivist learning design. Duffy distinguished between the goals of explicit instruction advocates, who desire learners to meet learning goals in the most efficient possible ways and the constructivist advocates, who highlight the motivations for learning, and offer direct assistance and advice only when learners ask for it (Duffy, 2009). Teachers placed in complex classrooms without adequate, domain-specific preparation, and without the beliefs and mental models that will allow them to respond to multifaceted cues and responsive interactions may develop what appear to be irrational behaviors (Feldon, 2007a).

While knowledge of the current situation and environment of teachers will be essential for any research on improving teacher performance, major conflicts remain between preparation programs and actual classroom situations, where teachers experience overwhelming frustration, and where classroom ecology needs to be understood and taught (Wideen, Mayer-Smith, & Moon, 1998). The levels of task complexity cannot be used as an excuse for unguided training. On the contrary, the complexity of tasks should serve as motivation for developing tools to analyze complex tasks and designing instruction that will optimize learning of these.

The classroom as a complex environment. CLT explains challenges faced by student teachers regarding the challenges within teaching tasks and their complexity (Moos & Pitton, 2014). Distressed teachers experiencing cognitive overload are in need of complex learning design. An important tenet of CLT is that there must be an alignment between the cognitive responses of working memory and long-term memory in the learning environment (Paas, Renkl, & Sweller, 2003, 2004; Sweller, 1999, 2004). Interactions within the complex environment must be understood and aligned with complex cognitive tasks. The massive complexity within teaching itself provides the reason and relevancy of CLT, and of the need for automaticity in some of the most basic, supportive teaching practice.

Classroom ecologies are massively complex systems that must be managed by teachers both expert and novice and demand complex learning on the part of teachers. In classroom ecologies, environments and situations are always changing. Teacher actions and perceptions are brought together through the requirements of the classroom ecology, and the meaning of teaching arises from these interactions. This ecological reality, which is not merely physical and external, becomes a meaningful and significant series of patterns through the actions of teachers within it (Flach, 2000). McDonald (1992) explains there is a vibrant interaction between teachers, students, and the material to be taught that is always shifting.

Lampert (2001) affirmed that the teacher must decide to teach and how they grasp the subject is a question complicated by the feeling and thinking of students toward the teacher, toward other students and the subject matter. Constant issues of how fast or how slow or how deeply to teach a subject create even more complexity, and many of the problems that must be addressed by teachers occur simultaneously, not one after another, such that single actions on the part of the teacher must address many immediate challenges.

The skills associated with teaching are never routine for the tasks of a teacher must meet multiple goals, often simultaneously. Classroom instruction is accomplished in relationship to diverse groups of students with different needs and teaching requires many kinds of knowledge that the teacher must integrate (Lampert 2001). Other issues make teaching more complex, including incidental missions of contemporary schools and their ambitious curriculum goals. On a daily basis, teachers must manage behavioral and intellectual processes that are active and dynamically changing as a classroom moves forward, with a high level of rigor (Darling-Hammond, 2008). In their role, teachers discover multiple challenges on many levels and must respond to all to be effective when interacting with individual students, managing groups of students and entire classrooms, and in incorporating the larger school's goals.

In his early study on classroom ecologies, Doyle (1977) found ethnographic data on student teachers indicating classrooms characterized by multidimensionality, simultaneity, and unpredictability. Teachers, in turn, developed strategies, such as chunking, differentiation, overlap, timing, and rapid judgment, to reduce the complexity of these demands. In her study of the development of research on teaching, Elizabeth Green (2014) reviewed the work of Lee Schulman, who studied both the cognitive development of physicians and teachers in the late 1960s and compared the profession of teacher and doctor in terms of complexity. Schulman pointed out that like doctors in the process of diagnosis, teachers had to decide how to respond to ongoing cases of need on the part of pupils. Teachers also regularly dealt with new issues on a minute-by-minute basis (Green, 2014).

Schulman compared the complexity of teaching to the that of a physician who faces a hospital emergency during a natural disaster, and he lists the multiple goals at work with 25 to 35 youngsters (or patients), as the teacher simultaneously focuses on decoding and comprehension, student motivation and love of reading, all the while monitoring a half-dozen students immediately in front of her while not losing track of the other two dozen also in the class (Shulman, 2004). His comparison does not even include basic classroom management techniques that must be employed to achieve constant student engagement and attentiveness. While the medical and teaching fields do compare regarding complexity, they do not compare in how each transfers expertise. Although medical educators seem to have successfully embraced principles of instructional design from CLT, teacher education has not (Qiao et al., 2014; Sweller & van Merriënboer, 2010).

Expert and novice differences. Cognitive psychologists consider the problem of classroom complexity through the study of authentic activities, knowledge and reasoning of expert practitioners in their real-world environments (Hoffman & Militello, 2014). CLT explains differences between experts and novices in terms of how long-term memory interacts with working memory in complex environments (van Merriënboer & Kirschner, 2013). From the perspective of cognitive psychologists who study expertise development, novice teachers have few schemas in place in long-term memory to support their working memory in the situations before them, and will have different learning needs and goals than experts (Feldon, 2007a). Teacher acquisition of problem-solving skills will not happen through one learning approach, but includes many strategies, according to CTA (Hoffman & Militello, 2014). According to van Merriënboer and Kirschner (2013), a novice will build schemas in two ways, depending on the goals of tasks. Nonrecurrent elements are best learned in a setting of complex problem-solving. Recurrent, rule-based processes are best taught using drill. Designers of teacher education should have a respect for both, depending on levels of skill development and technique characteristics, and design sequences that build from automating the recurrent to create more working memory space for the nonrecurrent tasks.

Under-developed schemes are one way to understand differences between expert and novice response to classrooms (Chi, 2006; Feltovich, Prietula, & Ericsson, 2006; Ropo, 2004). The complexity of the classroom and the diversity of the cues and stimuli that teachers must respond to cannot be discounted in measures of mental effort and in designing instruction for teachers. One area of teaching practice to which cognitive psychologists have devoted some analysis serves as an example for designers of complex learning: the level at which teachers notice classroom events (Sherin, 2007; Sherin & van Es, 2009; van Es & Sherin, 2008). Sherin and her colleagues, exploring the use of videotaped lessons for teacher development, noted changes in the way teachers notice classroom events, shifting from attention to the teacher to a focus on student signals and interactions.

Teachers demonstrated the ability to make improvements to their practice by watching videotapes of lessons (Sherin & Han, 2004; van Es & Sherin, 2008). Researchers have emphasized noticing students as a focus of teacher education (Frederikson, Sipusic, Sherin, & Wolfe, 1998; Jacobs, Lamb, & Philipp, 2010; Santagata, Zannoni, & Stigler, 2007; Sherin & Han, 2004; Sherin & van Es, 2005, 2009; Star & Strickland, 2008). Van Es and Sherin (2008) have developed the standard definition of the skill of noticing, which includes identification of critical elements that are relevant or irrelevant, connecting specific interactions in the classroom with the larger goals of teaching and learning, and utilizing contextual knowledge to analyze and respond appropriately to classroom happenings. Some researchers have focused on how novices compare to experts in their responses to watching classrooms and noticing events.

It is possible to differentiate between expert and novice skill in noticing students. In the research of Berliner and colleagues (Carter, Sabers, Cushing, Pinnegar, & Berliner, 1987), students examined slides of classroom situations and were asked to determine and analyze events. While novices could only give descriptive details of what they were seeing, experts ordered classroom signals into information categories that allowed them to identify and interpret student signals. Experts drew from well-formed long-term memory schemas, were less confused and able to discern the meaning of classroom happenings, were able to make more comments with more detail and were able to assess situations and offer prescriptions for classroom events. They were also able to discern relevant and irrelevant information. Pertinent information escaped the attention of novices.

In other research of expert and novice differences, Leinhardt and Greeno (1986) studied classroom teachers lesson planning and execution with observation instruments, video recording and interviews, and noticed how expert teachers excel in their domain of teaching and are more sensitive to social and task challenges while solving problems (Leinhardt, 1989; Leinhardt & Smith, 1985). The experts could make sense of multiple happenings and create meaningful patterns of classroom events. They could distinguish and attend to necessary items. The experts were flexible in seeing different perspectives in context and were able to give hypotheses for student behaviors and offer immediate solutions.

Borko and Livingston (1989) utilized the cognitive psychology framework to identify major differences between expert and novice teachers. After observing differences in practice, they concluded that novice teacher schemata were not as elaborate, their working memory and long-term memory were less interconnected, and schemas were not as accessible to the novice. New teachers' pedagogical skills were, therefore, less developed (Borko & Livingston, 1989). The diversity of student needs, subtle cues, and pedagogical scripts that must be applied represent the complexity of the classroom, which expert teachers learn to navigate and nurture.

Regarding complexity, Feldon (2007a) too is astonished by the quantity of sensory and semantic cues that teachers must simultaneously process in the classroom, considering the limited capacities of working memory. Meeting the learning goals of all students within this ecology does not seem possible. But the expert teacher attempts the impossible. The expertise of teachers, acquired by experience, is exhibited in processing behaviors that are similar to those of experts in other areas, including the medical field (Sweller & van Merriënboer, 2010; Qiao et al., 2014). Feldon (2007a) cites a large body of research on teacher expertise that indicates how expert teachers are more able to handle complexity in the classroom. They can differentiate between relevant and irrelevant cues in classroom settings (Allen & Casbergue, 1997; Kagan & Tippins, 1992). Their navigation skills in the complex classroom allow them to apportion a large segment of their mental effort to germane CL rather than extraneous factors (Berliner, 1986, 1988; Sternberg & Horvath, 1995).

With a greater variety and number of schemas to draw from, expert working memories can handle information in the complex classroom more efficiently (Ericsson & Kintsch, 1995; Gobet, 1998; Gobet & Simon, 1996, 1998; Masunaga & Horn, 2000). An example might be taken from the teacher who has practiced many recurrent forms and techniques of classroom management; they may circulate, redirect distracted students, communicate watchfulness to keep students engaged, perform low profile physical gestures that move students forward, and communicate steps in transitioning activities, all without using much working memory space. During these activities, their working memories may be fully occupied with more complex tasks of eliciting and interpreting student thinking and offering students new ways of thinking through problems during a lecture. Expert teachers can automate their procedures in evaluating and responding to classroom events, and these events pose smaller amounts of CL (Blessing & Anderson, 1996) so that they may attend to the classroom more effectively and handle complicated classroom interactions (Feldon, 2007a).

Summary. What do cognitive psychologists recommend for learning designers who are preparing teachers for these complex environments? After reviewing research into teacher automaticity and CL, Feldon (2007a) offered directions for future research in the area of CLT and classroom instruction. Such research must consider the dynamic relationship between the phenomena of CL and teacher training and performance and should be integrated with attempts to study the classroom as an ecological system with meaningful patterns of interaction, as described by Nuthall (2005) and Wideen, Mayer-Smith, and Moon (1998). Feldon (2007a) concluded that a focus on automaticity would increase teacher effectiveness and decrease teacher stress, and further claimed that research on assessment of teacher CL as it dynamically fluctuates will offer a new, multitiered way of understanding performance and help to discern better designs for teacher preparation.

This section has considered the larger complex environment of teachers and the challenges that this environment presents to learning designers and novice teachers. It has taken the large view of the total classroom, what phenomenologists often call the life-world of the subject. It is necessary now to decompose the practices of teachers in this complex environment, to examine the specific acts that comprise the expertise that learning designers hope to transfer, and how learning design organizes and presents these items to the novice. The researcher must come to understand the characteristics of teaching on the level of individual teachers' cognitive processes, what underlies each teacher's interactions with students and with learning tasks (Kalyuga, Ayres, Chandler, & Sweller, 2003).

Section Three: Lemov and Teacher Learning Design

It is entirely possible that a novice teacher could be placed in a classroom without a thorough introduction to expert techniques, and that this lack of tools to meet everyday goals of the classroom affects his or her experience of mental workload. The researcher exploring CL with novices and observing teacher classroom activities will attempt to elicit a novice's combinations of mental activities, interactions in the classroom environment, and attempts to reach the goals of teaching in specific acts and iterations. Yet there appears to be a gap in education literature in the area of classroom teacher CTA, and a lack of reference to CLT in the literature of novice teacher learning design. This section explores a framework for understanding teaching as expertise transfer, that has analogous principles to CTA, and that considers mental workload in teacher instructional design.

The work of Doug Lemov (2016) and his colleagues (Lemov, et al., 2012) represents a new perspective on teacher expertise transfer that is analogous to CTA and takes into account mental workload in practice design. This chapter evaluates their approaches to teacher taxonomy and professional development, demonstrating clear analogies with CLT's approach to expert development, and how these trainers use their own form of CTA. This evaluation makes a case that Lemov's taxonomy provides a powerful example of how the concepts of cognitive psychology and CTA may be applied to teacher learning. Specific items recognized as endemic to classroom management will be identified and explored. The attributes of items of expert teacher practice and cognitive skills are elaborated, which will assist in bridging the theoretical framework and practical application in complex classroom environments. This section of the review enhances the methodology section by showing how CTA informs the study of CL, and how CL impacts specific items of teaching.

The basic subtasks of expert teachers. A prominent body of literature regarding teacher expertise presents items for teaching practice. The taxonomy of teaching practice of Doug Lemov (2016) was chosen for very specific reasons. Lemov and his colleagues (Lemov, et al., 2014) have developed a framework for expert ("Champion") teaching practice particularly salient for this research. The choice of Lemov's design was neither arbitrary nor based on the popularity of his system, but for reasons relevant for phenomenological research in the area of CL and classroom instruction.

Lemov's conception of expertise mirrors that of CL theorists. Also, his methods of analysis of teacher skills reflect CTA methods utilized by instructional designers for development of expertise. The principles and goals he analyzes for practice also mirror the instructional designs within CLT. The language he uses in his taxonomy facilitates the analysis of intrinsic load within tasks, by offering decomposed techniques within larger schematic categories. The comparison of Lemov and colleagues' framework for teacher instruction (which includes a high level of concern for mental workload and automation) and the work of CL theorists offers a language to better understand the fluctuations of mental workload that occur for novices while enacting the tasks of teaching.

Doug Lemov's taxonomy. Elizabeth Green (2014) has documented the work of Doug Lemov as the developer of a new language of teaching. She described Lemov's early frustrations with American education, his studies of data and data-driven systems and his work with charter school start-ups. These formative influences culminated in his rejection of progressive pedagogies that contribute to disordered classrooms and the isolation of teachers or a "lone ranger" approach to teachers who develop as soloists (Green, 2014, p. 163) without support, as well as his early attempts at documenting successful practice. Frustration with educator inability to isolate successful practice techniques (Greene, 2014) helped Lemov realize the need for a "'common vocabulary' to describe the elements of good teaching" (Green, 2014, p. 175) and the initial creation of items of his taxonomy. Lemov traveled to dozens of schools with a videographer in order to capture and record expert teachers at work, and to find solutions and techniques of excellent teaching through an analysis of teacher practice.

Within the charter school system in which he worked, Lemov responded to a change in their approach to acquiring quality teachers, from finding and hiring talented teachers to building talent. When first encountering expert teachers, he noticed what others would describe as magic, that expert teachers seemed able to do miracles through sheer personality. Observing these teachers more carefully, he discovered intricacies of teacher-student interaction, analyzed a series of principles that teachers followed, sometimes consciously, sometimes not, and witnessed a group of moves and responses that they were able to choose and enact consistently in specific situations. Capturing and analyzing expert practice led to reflective writing and sharing of ideas and videos with many colleagues and an accelerated collection of data (Lemov, 2010). Exchanges associated with sharing the taxonomy and the techniques brought adoption by other teachers and improvement and clarity; a culture of constant dialogue, analysis, practice and change developed among the teachers who shared his research with each other.

Lemov's selection process of expert or champion teachers was based on data of individual classroom performance (according to state test scores and achievement profiles) within a heightened poverty demographic (Lemov, 2016). He identified classrooms with both the highest poverty and the highest achievement levels, and found the teachers he describes as outliers, those instructors who worked among the most challenging demographic but who performed exceptionally (Lemov, 2016). These outliers became the focus of his research. Green (2014) compares Lemov's research approach to Japanese Lesson Study, or jugyokenkyu, which develops language of teaching organically through close observation, group analysis and post-lesson discussions.

Lemov's team built the taxonomy deliberately by observing videos, analyzing, discussing, and taking notes (Green, 2014). Further, his approach spurned the frameworks of teacher education schools, whose experts "failed to help their teachers to teach well" (Green, 2014, p. 194).

Other researchers indicate the effectiveness of studying experts in their real, complex environments. Ericsson and Towne (2010) distinguished two research approaches to expertise. They identified one as a traditional approach, where practitioners expect a continual growth of a novice to expert as a result of time in the field, their years of experience and training, with no gauges that would allow for skill replication. The second approach identifies individuals with expert performance in representative tasks, specialists who embody expertise in their particular domains. This group is observed to determine their superior skills, and their performances are analyzed, along with critical processes and their underlying mechanisms (Ericsson & Towne, 2010).

According to Green (2014), the majority of the teaching profession interprets teacher expertise according to the first, traditional model, that teachers simply grow over time. But as an outsider not hindered by conventional expert presumptions about performance, Lemov (2016) utilized techniques of performance analysis, saw more of the elements of teaching and decoded them. Feldon and Stowe (2009) also have presented similar analytical tools of CTA as a model of decoding expert practice.

For purposes of validating Lemov's method, one could easily call Lemov's work a grounded theory study. Grounded theory is a method of research that constructs conceptual frameworks and theories through rigorous inductive analyses, data gathering, and testing of theoretical interpretations of data (Charmaz, 2014). Lemov's broad collection of video observation data and teacher interviews and the subsequent analysis and note-taking resemble this, as well as his development of analytic categories, which, according to Charmaz (2014, p. 342) are grounded in data. Grounded theory methods favor analysis over description and look for fresh categories to replace preconceived ideas and accepted theories. Grounded theory research designs also prefer systematically focused and sequential collections of data over large samples. These qualities characterize Lemov's research. Grounded theory researchers are involved in data analysis while collecting data, and both processes inform and shape one another in an iterative process that eliminates sharp distinctions between both (Charmaz, 2014).

For his own research sample, Lemov chose top performing teachers. He observed and analyzed performance to find the common skills these performers share. By analyzing and describing the skills of experts, Lemov has provided a map for novice teachers, thereby analyzing the "game" of teaching (Lemov, et al., 2012). One might assert that what Lemov has done is not grounded theory research since there is no representation of a theory of teaching generated in *Teach Like a Champion* (2016). However, there is a positive alignment between the goals of CTA, which analyzes expert performance from the outside of the experts' own conceptions of their practice, and the goals of phenomenology. Like Lemov, both phenomenologists and cognitive task analysts will bracket the natural attitude (Sanders, 1982) toward how teachers are trained and their learning experiences in order that the phenomena associated with teacher learning may be experienced in a different and unconventional manner. They are also both concerned with the environment in which phenomena are experienced, what Husserl called the lifeworld or lebenswelt, to which the consciousness is always attached, and what some learning designers call real-life tasks. Real-life tasks are those within a complex environment, with problems cannot be well-structured and where solutions cannot be limited to specific domains; as in the classroom, the solution to problems will never be simple for teachers (van Merrienboer & Kirschner, 2013).

Like cognitive task analysts, Lemov and colleagues (Lemov, et al., 2012) developed a theoretical approach to practice that forms a framework for expertise transfer. The collaborative observation and analysis of teacher performance led to the generation of cognitive tasks and processing for effective teaching. This result, in turn, generated a larger process of transfer of expertise among teachers and school leaders and the provision of a set of rules for practice.

Lemov's iterative process involved expert teams of teachers and observers in an ongoing dialogue regarding practice 'moves' and the development of a new language to describe effective interactions. (Green, 2014) Essential to this process is coding, the process of taking apart the data and categorizing what data is about, wherein qualitative codes define what is seen in the data, and codes are emergent. Grounded theory research also depends on coding as researchers interact directly with data, allowing the process to take them to new areas of exploration and questions (Charmaz, 2014). In summary, the grounded theory research approach contains four legitimate criteria. They are credibility, originality, resonance and usefulness (Charmaz, 2014). Lemov's research indicates all of these, as does the theoretical product, his framework for developing practice in many different areas of performance (Lemov, et al., 2012).

The goals of this study are phenomenological, and different from those of Lemov's grounded theory approach. While grounded theory favors analysis over description, this phenomenology will explore the rich descriptions of novices. However, a phenomenological research of CL in novice teaching also will demand a language of expertise in teaching practice, and categories for identifying the decisions and actions of teachers. Meaningful practices are those that fit in the context of the complex classroom, authentic and real-life tasks, and experts are those who model them. Lemov calls his experts "Champions" (2016), which reflects his view of excellent teaching but also indicates his reliance on expert classroom teachers. He rejects the expert advice of traditional university settings. There are advantages in Lemov's rejection of education schools' approaches and his development, through observation and teacher-task analysis, of a new taxonomy for teaching. It is important in evaluating these advantages to remember what cognitive psychologists have discovered regarding expert self-reporting. We have already reviewed research that indicates how blind spots fill expert self-reporting, and the disconnection between expert descriptions of their practice and the procedures they utilize in authentic environments (Tofel-Grehl & Feldon, 2013). Lemov is filling a gap in the study of teacher practice through careful analysis of observed expert techniques, and his own methods of eliciting unconscious, automated schemas of expert knowledge.

Lemov also conceived the goal of teacher education as building talent to a high degree of automaticity. In their book *Practice Perfect: 42 Rules for Getting Better at Getting Better*, Lemov, et al., (2012), presented rules for practice that mirror the goal of CLT, to reduce extraneous load and to develop long-term memory. The authors describe teacher automaticity through the story of a teacher named Sarah who developed a recurrent skill into a habit through practice (Lemov, et al., 2012). After practicing for a while on a particular skill, she lamented to an observer that she had not demonstrated it in class. Her observer had seen it used numerous times, and she had been doing the task repeatedly without realizing it. Lemov and colleagues claim that once one has acquired a skill to automaticity, the body will execute it and the mind, afterward, catches up (Lemov, et al., 2012). He stresses that such automaticity is the goal of practice and supports other, more important tasks within the classroom.

Awareness negatively affects automaticity, and often gets in the way of expert performance (Lemov, 2012). It is important to automate fundamental, simple techniques, but one must also build to the more deft skills with greater complexity. Complex tasks also respond to practice, under the correct conditions, and become habits. In "Rule 4: Unlock Creativity . . . With Repetition," Lemov and colleagues (Lemov, et al., 2012) describe what the conscious mind is doing while non-conscious thought processes are being carried out. Citing the experience of athletes who have practiced and for whom a game "slows down," they describe how during a game the minds of expert athletes have a new capacity for processing. Complex actions that once occupied all of their mental processing and were more difficult have come, through practice, to occupy a smaller portion of mental processing. To unlock one's creativity, one must identify skills required at particular moments and automate them to "free up more processing capacity for creative thinking" (2012, p. 37). This description matches what CL theorists look for in schema acquisition, that the development of schemas frees working memory for nonrecurrent tasks and higher order thinking. Practice, as Lemov and colleagues (Lemov, et al., 2012) describe it, increases repetition of tasks to unlock the capacity for creativity and individuality.

Cognitive processes that require little or no conscious effort indicate automaticity has occured (Feldon, 2007a). When an automated action is initiated, it happens without intention and is not subject to conscious monitoring. Automated actions require little attention on the part of the expert, and occur rapidly (Feldon, 2007a). Leinhardt and Greeno (1986), whose study compared novice and expert mathematics teachers, confirm these observations. Expert routines are the result of structured schemas in long-term memory that give them room intellectually and temporally to deal with challenging parts of teaching. The capacity for an expert teacher to be creative is expanded because, as described by Lemov, expert working memory can accommodate the complexity of the classroom and adapt to new events (Feldon, 2007a).

Lemov's taxonomy and schema decomposition. The purpose of Lemov's (2016) taxonomy is to respond to the endemic problems of the classroom. These are the opposite of exotic problems and endemic means that the typical classroom has many issues that, while complex, are also predictable, or that we are confident will happen (Lemov, 2016, p. 5). This categorization mirrors that described earlier in this review, although CTA labels skills as recurrent or nonrecurrent within the task hierarchy. Instead of choosing the exotic as the subject of teacher education, as many experts do, Lemov focuses on those skills that help teachers solve the predictable, without implying that the endemic problems are simple to solve. He chooses a sequence that moves from simple to complex, eliminating the extrinsic distractions and isolating specific skills outside of the classroom. (Lemov, 2016)

In the area of teacher education, Grossman and colleagues have approximated the approach adopted by practitioners of CTA and Lemov for teacher development. Education of teachers consists of the three instructional elements of representation, decomposition, and approximation of classroom practice (Grossman, et al., 2009). Representation of practice offers examples of classroom practice, such as video of classroom practice, so that teachers can develop new ways of perceiving their practice (Grossman et al., 2009). Decomposition refers to the need of novices to perform the constituent parts of complex expert skills before integrating these skills. Complex practice is broken into components and allows teachers to enact smaller elements of teaching. Approximations of practice incorporate enactment and experimentation with the parts of practice, out of the authentic classroom with students, which allow for mistakes, support, and feedback. Grossman et al. (2009) conclude by declaring that most preservice teachers do not have many chances to engage in such approximations. Lemov's approach mirrors this framework, as his research represents teacher practice and analyzes its techniques for the sake of approximating in practice teacher expertise.

There is also a powerful analogy between Lemov's analytical representation of teacher practice, his decomposition of expert moves, his descriptions of approximation of practice, and his ways of meeting the learning design goals of CTA in the transfer of expert performance. Feldon and Stowe (2009) advocate CTA and its tools for elicitation of expertise as a method for refining expert information reporting. Three independent elements are involved: knowledge elicitation, analysis, and knowledge representation. Expert or champion teacher techniques become usable through these when education designers can present the content in practical and concrete formats. Lemov's approach of eliciting and recording expert teacher practice, analyzing teacher performance and decomposing that performance into elements, and the knowledge representation (shared language of teaching) within his taxonomy, mirrors this approach (Crandall, Klein, & Hoffman, 2006).

Lemov published his resulting taxonomy in *Teach Like a Champion: 49 Techniques That Put Students on the Path to College* (2010) and a subsequent edition, *Teach Like a Champion 2.0: 62 Techniques That Put Students on the Path to College* (2016), which significantly updates the former work. In the second edition, he distinguishes his approach from that of others who promote lofty words of advice such as "Have high expectations of your students" and "Expect the most from students every day," or "Teach kids, not content" and tells of his discovery that "specific, concrete, actionable techniques" were far more valuable (Lemov, 2016, p. 8).

The language Lemov employs to describe teacher practice presents a shift from traditional nomenclature. Although the teaching profession tends to call the tools of teaching "strategies," Lemov (2016) calls them "techniques" (p. 9). He found the term strategy used in a way that was too comprehensive, although strategies do inform decisions. Techniques, however, have to do with the particular manner in which something is said or done in teaching. The example he gives is a sprinter who may have a starting strategy of getting quickly out of the blocks and then running from the front. The technique of the runner is to incline forward at a certain number of degrees as he drives his legs up and out. Practicing and refining a technique would make one a great sprinter, while emphasizing the strategy would not (Lemov, 2016). This change represents a shift in learning design from large schemas of teaching to its simpler, decomposed elements.

For classroom practice, mastering techniques that will help to navigate a lesson is more productive than developing teacher convictions regarding students for Lemov. His *Teach Like a Champion* (2016) is a decomposition of recurrent practices into their most essential elements. The book's techniques are not a "system," but merely "small, discrete units of inquiry" which may be chosen and studied for quick improvement and results, and incorporated into a teacher's regular practice (Lemov, 2016, p. 9). What separates the champions (experts) from others "are actions that are granular, specific, far beneath the level of philosophy and knee-deep in the weeds" (Lemov, 2016, p. 12). From the large schemas that represent teaching practice and the long-term memory of teachers, practices must be analyzed into such techniques, decomposing schemas into the necessary elements that may then be represented and named and then appropriated in practice.

In their book *Practice Perfect: 42 Rules for Getting Better at Getting Better*, Lemov, Woolway, and Yezzi (2012) explain the principles of practice design, which begin with representing the technique to be practiced. He discusses the importance of representing skills with names in "Rule 11: Name It." Names of skills should be both logical and memorable and are meant to shape the practice of the skill. Skills not only need identification, but researchers must bring to the surface the discrete skills that are named so that they may provide clarity for those practicing them (2012). For the sake of professional development and conversations, teachers need a code for quick reference that refers to game-changing, recurrent techniques.

"Rule 12, Integrate the Skills," presents practice design along the same lines as found in CLT, and the particular architecture of human consciousness. Discrete skills are built into larger schemas. Trainers integrate techniques through game-like scenarios, through matching correct techniques to the situations that call for them, and through taking practice to the authentic context and environment in which teachers will utilize them (2012). In Four Component Instructional Design, learners also must perform increasingly complex skills until these compile as whole-task practice (Clarke, Feldon, van Merriënboer, Yates, & Early, 2010).

Instructional design principles in cognitive load theory and Lemov. Cognitive psychologists like Feldon (2007a) recognize that approaches to teaching that focus on theory may allow novices to avoid rehearsal of teaching skills before working in classrooms and that teachers who lack sufficient practice do not develop skill automaticity. Teachers cannot construct new procedures quickly in real instructional situations and interactions, as other conscious processing is going on. Effective procedures are developed to generate expertise using CTA, which elicits expert's knowledge to identify unconscious steps in a process needing decisions. Next, cues that trigger decisions are identified and these decisions, in turn, are brought together and linked to sub-skills that will be employed. (Clark, Feldon, van Merriënboer, Yates, & Early, 2010).

Procedural and conceptual knowledge represent two ends of the teacher development spectrum, the first based on real-task, hands-on practice for authentic environments, and the second found in the traditional university classroom. The choice of one or the other affects training effectiveness. Procedural knowledge has traditionally been considered effective for skills applications in authentic domains. The traditional approach to solving complex problems is based on conceptual knowledge that helps learners grasp the most profound structure of a domain, as well as the kind of productive analogies that will allow for applying knowledge in multiple situations (Schwartz & Martin, 2004; Feldon & Stowe, 2009).

Procedural knowledge, learning that lends itself to drill, has been considered too rigid for complex domains because automaticity or over-routinized behaviors (inflexibility to new problem solutions) resulted (Ericsson, 1998, 2004). Recently, these impressions have been changed by research regarding the effective transfer of knowledge that includes deliberate practice (Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Paas, 1992; van Gog, Paas, & van Merriënboer, 2006). Other researchers have compared conceptually oriented, traditional instruction with a worked example approach that includes demonstrations of each particular step of learning (Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Paas, 1992; van Gog, Paas, & van Merriënboer, 2006). Worked examples perform better and have been shown to be more efficient (Feldon & Stowe, 2009).

The goal of teacher preparation, based on premises of CLT, is the transfer of knowledge from working memory to long-term memory in a way that optimizes intrinsic load and eliminates extraneous load. As skill development grows, novice teachers integrate the sub-skills or parts of a complex task into schemas. Lemov, et al., (2012) approach to practice involves much the same process. In the section entitled Rule 10: Isolate the Skill, they describe how trainees practice identified skills in their simplest form. The eventual goal of all transfer is to utilize all skills in the integrated setting of the classroom, but isolation in a simplified setting, or drill, is the necessary first step. Decomposition of complex tasks leads to the isolation of specific, simple techniques. Problems to be solved are planned and predictable, and skills are practiced until learners have mastered these.

These simpler skills do not remain isolated; teaching requires that many simultaneous processes and interactions come together. In “Rule 12: Integrate the Skills,” Lemov, Woolway, and Yezzi (2012) describe how discrete skills are brought together in situations teachers may face in the classroom, and teachers are trained to match correct skills with classroom situations. The authentic context of the classroom must be simulated for this to occur (Lemov, et al., 2012). For this reason, Lemov distinguishes drill from scrimmage in describing types of practice.

According to Lemov, Woolway, and Yezzi (2012), one must distinguish drill from scrimmage. Drill simulates a controlled, safe setting and allows participants to focus on specific skills with greater concentration and refine those skills in a very intentional way. Trainees concentrate mental energy on a well-decomposed technique to the exclusion of extraneous distractions. Scrimmage, in contrast, replicates the uncertainty and complexity of the classroom scrimmage involves combining the constituent elements of teaching into whole-task practice, bringing the hierarchy of skills together into the complex activity, replicating its uncertainty and complexity. (Lemov, et al., 2012). A teacher may practice Lemov’s (2016) Technique #15, Circulate with drill and scrimmage. The teacher practices a lesson without students and drills by strategically moving around the classroom, breaking the plane early in the lecture (an imaginary line that separates the front of the room from student desks), and systematically conveying that the entire workspace belongs to the instructor. With other teachers or in the classroom, the teacher scrimmages by strategically circulating and simultaneously noticing off task behavior for which to apply proximity, while communicating verbally and non-verbally the next steps of a lesson or assignment, and maintaining high levels of engagement among students.

If an item is recurrent and simple, involving fewer steps, this item will be more identifiable for the teacher. If an item is nonrecurrent, it may be irrelevant to the practice of many teachers, an exotic skill outside of general teacher experience and even expertise. For example, all teachers will utilize nonerbal cues to redirect off task students, and this is recurrent. A nonrecurrent activity would occur during a specific geometry lesson wherein a teacher elicits a student's thinking about a problem, finds a unique but off-track approach, and the teacher creatively redirects student thinking and helps them find the solution. This nonrecurrent activity has recurrent elements, eliciting and interpreting student thinking, but the particular thinking and solution will often be as unique as the student. If the teacher must do this nonrecurrent activity while also needing to use a lot of mental effort on recurrent issues, the former may become overwhelming. When it comes to supporting teachers, it makes better sense to choose items most endemic to teaching, items that are predictable, useful, and that teachers must develop not only in order to be effective but for basic classroom survival. Recurrent items are still often complex. Even the most basic subdimension of a recurrent performance, such as getting a student across the room on-task with a glance, would involve the steps of (a) noticing off-task behavior, (b) deciding on whether to use a low-profile physical gesture or a low-profile verbal exchange, (c) deciding on the type of low-profile gesture to use (a "teacher-face", circulating with proximity, a roll of eyes, or catching the student's eye and glancing at the work on the desk in front of him), and (d) squaring the shoulders toward the student, clearing the throat, and waiting for the student to notice.

Recurrence, complexity, and the TNTP model of expertise transfer. The level of a task's complexity and the recurrence of the task in the classroom will impact the amount of mental workload a teacher applies to it. Levels of recurrence and complexity are considered in CTA development of skills hierarchies, with the less complex and more recurrent items supporting the more complex and less recurrent items of classroom teaching. A good example of how skills hierarchies might be used in learning design to support teacher learning comes from The New Teacher Project (TNTP). TNTP is an organization that has studied such items in partnership with Doug Lemov. TNTP's focus is on helping urban school districts and states who are in need of new teachers, designing training, evaluation and retention programs. Their work has led to multiple studies on district, state and national policies and practices that impact the teaching workforce (TNTP, 2016a). Michelle Rhee founded TNTP in 1997, and at first focused on helping districts with recruitment, training and hiring of new teachers. The New Teacher Project seeks to bring minority students equal access to effective teachers (TNTP, 2016a).

In 2000, the organization began the Teaching Fellows and Academy Program, which creates alternative teacher certification programs for high-needs schools. TNTP helped districts identify challenges in hiring and retaining teachers and providing more rigorous training, as well as critiquing policies that hinder the growth of effective teaching and encouraging various reforms (TNTP, 2016b). TNTP has recruited and trained more than 50,000 teachers (Menezes & Maier, 2014). The Teaching Fellows program sets as a mission the preparation of exceptional teachers to serve the most disadvantaged communities, and training focuses on the most basic skills and essentials. Teachers are given core skills during summer preservice training and then training broadens into more advanced techniques. The training emphasizes intensive classroom practice, expert coaching and personalized training based on novice teacher needs (TNTP, 2016c).

TNTP's Fast Start program was initiated in 2012 to upgrade preservice training with the goal of increasing beginning teacher effectiveness. (Menezes & Maier, 2014). The organization connected effective first-year performance to the skills of (a) delivering lessons clearly, (b) maintaining high academic expectations, (c) maintaining high behavioral expectations, and (d) maximizing instructional time. TNTP also recognized classroom management skills as a key indicator of future success. In 2012, representatives of TNTP began working with Doug Lemov and Erica Woolway to identify individual, practicable skills. The first year, 17 of the skills from *Teach Like a Champion* (Lemov, 2010) were taught, and teachers received equal time on each technique.

During the subsequent year, these same teachers demonstrated that some of the techniques increased success more than others, especially in regard to four techniques. Teachers who mastered these four particular techniques during their preservice training demonstrated greater immediate success in their classrooms. These techniques recurrent items of teaching, and met goals always present in the classroom. This narrower focus gave teachers a better picture of techniques needed for the classroom and allowed teachers to be attentive to skills for longer periods during a five weeks training program.

Although the complexity of the classroom demands more than the four skills chosen, these were considered the fundamental skills that supported a sequence of training to the more advanced instructional techniques (Menezes & Maier, 2014). TNTP emphasizes a focus on recurrent skills, practice and drill of these skills to support more advanced skills of teaching, and ongoing feedback. Feedback includes active observations in the classroom, where direct and specific classroom feedback focuses on practicable items, and immediate practice of items selected (Menezes & Maier, 2014). While the language of TNTP is different, the elements within their design reflect those already discussed originating with Four Component Instructional Design.

The four skills from Doug Lemov's (2010, 2016) *Teach Like a Champion* chosen by TNTP were: (a) 100%, the only acceptable percentage of students following a direction is 100%, (b) positive framing, making corrections to student behavior consistently and positively, (c) strong voice, a way for teachers to establish authority in their classrooms, and (d) What to do, providing students with specific, concrete, sequential and observable directions (Menezes & Maier, 2014). These items represent endemic complex tasks of effective teaching, as shown by TNTP's use of them, and also may be subject to decomposition to constituent parts, or simplification to sub-dimensions, as Lemov has done in his taxonomy of teaching techniques (Lemov, 2010, 2016). TNTP's choice of recurrent techniques that meet ever-present teacher goals serves as a model for this phenomenological study, wherein intentional choices regarding teacher learning practices must be made during observation and interviews, coding and identification of themes, and then phenomenological analysis of data. The lens of CTA may be used to analyze contributing factors to CL and provide more angles to view the phenomenon.

Methodological Review and Issues

This section reviews phenomenological research, the principles that guide explorations of human experience of particular psychological phenomena. The review lays a ground for the phenomenological exploration of teacher and expert coach experiences by exposing theoretical presumptions within teacher learning design, by offering a view of the life-world of teachers, and by presenting teaching techniques and a language of coding appropriate to the phenomena. CTA goes a long way in exposing flaws in expert perceptions of teacher learning and in demonstrating a wide range of causes for the various manifestations of CL. The voices of novice teachers, however, must be heard over the theoretical frameworks and practical learning designs, and in the process give a true form to the phenomena of CL as it impacts teacher learning and practice. A correct understanding of the goals of phenomenology will focus the research on this goal.

Edmund Husserl, the founder or phenomenology, developed a philosophical method that refused to separate mind from matter or nature, but that acknowledged that conscious human experience, the experience of something, is a fact that refutes any false dualism between mind and body or matter (Hammond, Howarth, & Keat, 1991). Truth and knowledge do not reside outside of human consciousness, but meaning and understanding are subjective in nature (Romdenh-Romluc, 2011). Every conscious subject's knowledge is characterized as having intentionality, a unique relationship between consciousness and an object of knowledge (Sokolowski, 2000). The understanding we have of an object will change according to our intentionality. For example, the way in which a teacher experiences teaching skills in the classroom will be very different from the experience of listening to an expert teacher give a lecture on teaching skills. The object of study is the same, but the intentionality of the teacher will be different in both instances. The teacher isolated from an actual classroom and the teacher within the classroom will experience teaching skills differently.

In order to develop a path to the essence of things, Husserl described a method that suspended or bracketed the natural attitude, as a way of experiencing phenomena in unconventional and new ways (Sanders, 1982). What the researcher takes for granted, their natural standpoint, must be set aside. Our unquestioning acceptance of the way things are is replaced by a sense of wonder, the philosophic attitude. This exchange of a natural attitude for the philosophical attitude is the phenomenological reduction (Stewart & Mickunas, 1990). Husserl revised his idea of transcendental subjectivity later in his life, and explored the idea of the lifeworld or lebenswelt. Later phenomenologists would emphasize how the individual person is embedded in the world, (Heidegger, 1962), that consciousness is always communicating with the world and that human being is experience in the world.

Describing the phenomena of CL in teaching is both a problem of the real-world complex classroom and of a deficiency in the literature of teacher-learning and of CTA. The literature review exposes the theoretical framework and the presumptions within teaching in alignment with its phenomenological design. The concern of phenomenological research is to understand social and psychological phenomena according to the perspective of the people being studied (Welman & Kruger, 1999), their lived experience.   The goal of phenomenology is to return to the pure phenomena, outside of theoretical or philosophical presumptions and the experience of the researcher, to get “Back to the things themselves!” (Moustakas, 1994) In order to do this, the phenomenologist brackets himself or herself from the study by exposing experiences with the phenomena or exposing theoretical assumptions regarding a phenomena (Creswell, 2013). Citing Georgi (2009), Creswell (2013) asserts that bracketing is not about forgetting an experience or pretending not to have assumptions, but exposing those to the light while engaged with the experience of others. Phenomenologists assert that researchers cannot detach themselves from their presuppositions and that they should not pretend to be so detached (Hammersley, 2000). Researchers hold explicit beliefs (Mouton & Marais, 1990). They must, using the method of phenomenology, control their bias. Since every qualitative study and its researcher have an underlying set of ideas and beliefs that inform research, the researcher must expose their personal, ethical and political issues, as well as the theories, paradigms and perspectives that guide their actions. Hence, the research has explored CLT and CTA as a theoretical framework to expose assumptions. More importantly, the findings of this literature review also indicate the need for a shift to the personal and internal experience of novice teachers as relevant data for novice teacher education.

Phenomenology is the appropriate methodology for this research because this study will attempt to locate the learning struggles of teachers within the lived experiences of teachers. Theories regarding expertise transfer and CL as these have been researched in many other domains of expertise transfer are not enough, and the study of teacher learning as it has been conceived in the natural attitude of current experts is not enough. The phenomenological method will allow the researcher and novice teachers to explore CL within the classrooms from different perspectives and stages and to describe teacher practice and experience with new levels of awareness. In this type of study, there is no way to confirm or deny a hypothesis, but it is a process of bringing together and analyzing interview data in order to establish themes and to identify the factors that contribute to CL and the ways in which load impacts teacher learning, practice and effectiveness. Research questions may guide the initial research, but only offer an idea of how to go forward. It would be presumptuous to describe exactly how this research will turn out or specific questions that may arise. The main purpose of phenomenology is to allow teachers to tell their stories as they alone can tell them, and understanding how the teacher thinks. Inductive reason is not the pursuit of thoughts, but it means allowing thoughts to come to us of their own. (Bogden & Biklen, 2007)

Van Manen (1990) discusses how the telling of stories creates openings to science through a process of reflecting on and clarifying our understanding of a phenomenon. Teachers can communicate their experiences through descriptions in stories that allow a researcher's consciousness to appropriate the structure of meaning within a lived experience. The current study is phenomenological because it describes an experience and reflects on the description in order to construct an idea of the nature of CL (van Manen, 1990).

Instrumentation

Van Manen (2014) articulated the conditions that make a truly phenomenological analysis possible, including appropriate phenomenological questions. Phenomenological questions guide analysis, because they focus participants on the lived experience of the phenomenon. Questions that are theoretical or abstract or that demand explanations and interpretations are not appropriate; the research must contain an element of wonder toward living phenomena. The novice teacher is managing a class of 30 students with a massive amount of input coming in even as she is trying to perform three tasks at once: one can experience wonder regarding the mental processes that guide her navigation. Phenomenological questions are focused on immediate experience, and such questions ask what a possible experience such as ever-changing levels of mental effort may be like. The current study will focus on how the teacher experiences this mental effort and how that experience either helps (intrinsic, germane CL) or frustrates (extraneous CL) their learning. Gathering what van Manen calls lived experience descriptions (LEDs) is difficult. He advises that the researcher attempt to capture experiences as they are lived through (van Manen, 2014). Questions such as: "What do you think of cognitive load theory?" or "Why do you think you have greater mental effort in this situation?" or "Do females experience more extraneous cognitive load than males?" are not helpful for phenomenology. The essential question is, "What was that mentally challenging moment like for you, as you taught in front of the class?" Everything flows from that prereflective experience, the concrete and un-interpreted experience of fluctuations in mental workload, or even the failure of memory at a critical moment. Other questions that follow may be more detailed. "Can you remember other times, even more extreme, when that happened in a classroom?" "What was it like to learn this skill and when did you know you knew it?" "When you executed this technique, you seemed different: what was going on there?" "What was different?" "What did you do?" "What did you feel?" "What was your proble-solving process?" Questions must serve to gain access to the story, to the prereflective experience. (van Manen, 2014)

According to Miles, Huberman, and Saldaña (2014), instrumentation refers to the methods for collecting data, and may be loosely or tightly structured. Technical choices must be made whether instrumentation consists of an open-ended interview or observations in the field. The conceptual framework and research questions provide focus for the researcher, and clarify what is being studied, from whom, and why. These questions lead to the problem of how the data is attained. (Miles, Huberman, & Saldaña, 2014) Observing and interviewing teachers are two ways to collect data regarding teacher CL, and observation and interview protocols, taken together, may associate the working memory of teachers in the performance of specific tasks. Since it is not possible to view teachers' mental capacity directly, tasks and happenings must be related to the felt effort, the working memory's engagement with that task. The researcher assumes that a certain degree of CL may be associated with every task, and that drawing out experiences of the phenomenon from teachers will be the great challenge of the research.

Moustakas (1994) indicated that the method of semi-structured interviews may be considered appropriate for this research because the research is centered on the internal perspective of the teacher, and not on an external point of view. While the research involves observing the teacher in his or her life-world, the real-life situation of the complex classroom, this is for the sake of the interview process. The semi-structured interview lets the experience of the teacher come to the surface. (Moustakas, 1994) From the initial questions asked, the researcher develops follow-up questions based on the experience that arises, with the first questions merely initiating a discussion that is led by the teacher. Semi-structured means the questions are not completely planned. Kvale and Brinkmann (2009) describe open-ended interviews as processes that involve interpretation as the conversation develops. When a teacher describes the life world of the complex classroom, he or she will perceive new facts about practice, and the researcher who summarizes and reflects on the stories of teachers within the flow of meaning is actually coauthoring the data. For exploratory studies, those that are heavy in description, the observer is not aware of the complex environment's rules or activities, and a more open-ended instrumentation is advisable; confirmatory studies that are more focused in terms of persons, events and processes demand a more well-structured instrument. (Miles, et al., 2014) In the case of investigating CL, there are both confirmatory aspects that demand greater focus and exploratory elements that may be related to teacher development, classroom environment, and situational performance.

The confirmatory aspects center on the construct, a theoretical composition, a set of abstractions, which organize and make sense of the environment (Pedhazur & Schmelkin, 1991). When we observe teacher practice, we notice events that might indicate a level of mental workload has had an impact on teacher learning and effectiveness, we could make an inference from this to the working memory and CL; if the teacher's experience confirms the inference, we say it has validity, and this validity is the level or degree to which the stories of the classroom teacher or coach indicate this mental state. CL and working memory are theoretical concepts that are used to explain changes over time and experience in a teacher's capacity to carry out effective techniques and problem-solve. Since one cannot observe mental constructs directly, they are called latent variables in quantitative studies. CL will assume a certain value and weight when associated by a teacher with the performance of an item of teaching, and the teacher narrative will elaborate the experience.

This phenomenological study explores various elements of novice descriptions for a deeper understanding of an idea that is rich and complex. Greater mental effort is an attribute of those experiencing heightened CL and empirical indicators of such effort could be many. A teacher experiencing higher loads may find their learning increased and feel sudden euphoria, encounter a specific inability to execute needed tasks, may be drawing a blank regarding what to do next, or freeze in place during a lesson, demonstrate an inappropriate or frustrated response to a simple situation, show a divided attention between tasks, or demonstrate a lack of capacity to maintain focus on lesson goals, might offer an unreasonable response to students, or show a lack of attentiveness to student cues, or expose emotional gestures associated with anxiety. There are different types of CL and they arise in different environments under disparate circumstances. The invisible construct increased CL could bring about these indicators, just as automaticity might bring about smooth sequential transitions between tasks, the performance of simultaneous techniques, or ignorance of recurrent responses to predictable management situations. Teacher observation should identify these empirical indicators of increased or decreased CL within specific teaching tasks, which in turn are explored by the teacher in the interview process.

The method of phenomenological interview established by Seidman (2013) offers a framework to enrich teacher descriptions of experience. He combines focused life-history interviewing with in-depth interviewing according to phenomenological principles. His approach offers a flexibility which can include many contextual realities, including teacher-education history and pre-conceptions of the life-world of the complex classroom (life-history), data about the experience within classroom practice, and the teacher's own reflection on the meanings he or she associates with the experience.

Three interviews are given to the participant, and not a single, in-depth interview, so that participants and researchers may contextualize what is being studied. The first interview is the "Focused Life History." This interview allows participants to describe the contexts and learning that preceded classroom practice, and participants are allowed to reconstruct early experiences. The second interview, "Details of Experience," allows a deliberate description of the phenomenon being studied, and the researcher searches for details of the experience. In the final interview, "Reflection on the Meaning," the experience is described by participants within the context; the meaning that a teacher attaches to an experience, the connection between teaching, mental effort, and learning would be explored. This interview also invites participants to describe the connection between previous life experience and their current situation, and the details of context and experience.

In the development of observation and interview protocols, the most important aspect of exploring the unseen mental activity of CL is the observation of novice teachers in the process of teaching and learning, the act of decision-making and practice with appropriate attributes, antecedents, and consequences. For Seidman's (2013) process of reconstruction to be completed, the second interview of this research demands observation, as the goal is to connect the actions of teaching with cognitive processes in the complex classroom environment, and details of classroom activity will help focus teacher reflection. Effective teaching is a complex composition of techniques, and each technique has constituent parts or sub-dimensions. For example, communicating high behavioral expectations is a skill that involves multiple interactions from students, actions on the part of the teacher, management, instruction and diagnostic noticing techniques. Observation precedes an interview about "Details of the Experience" because the researcher must associate real world decisions and practices with a teacher's described experiences. A teacher should know the item in question and that they have done it, and the steps involved in doing it. So CL must be evaluated by associating it with direct and circumscribed activities, not with unnamed complex processes that a teacher unconsciously engages, or has integrated completely. Constituent processes of complex techniques, and not large schemas, are easier to describe accurately.

Data Analysis: Coding Observations and Interviews for Thematic Analysis

To codify means to systematically order and arrange things, to integrate it with a system or to categorize. "Codes are labels that assign symbolic meaning to the descriptive or inferential information compiled during a study" (Miles, et al., 2014). Codes are applied to data in order to segregate the data, group it and regroup it so that meanings may be consolidated (Saldaña, 2013). Citing Bernard (2011), Saldaña (2013) affirms of analysis that it is a search for patterns and explanations of patterns, and that coding provides a method to organize data from experience that share the same characteristics. It also serves as a heuristic, a way of discovery and exploration that links empirical data to ideas and ideas to the data. When codes are applied and reapplied to data, segregated and relinked, this process consolidates meanings and explanations associated with the data and helps to identify patterns which are present. Data may be coded and placed into categories that demonstrate similar characteristics.

In qualitative research, codes and categories emerge and patterns emerge, separate cycles of coding refine perspectives, until, after recoding and recategorizing the data, the categories begin to transcend the reality given in the raw data and become thematic, conceptual and theoretical (Saldaña, 2014). Themes and concepts may become assertions and theories when raw data is translated in the coding process. Explorations of CLT and CTA, as well as Lemov's taxonomy and theory of teacher learning design, offer a framework and focus for coding teacher practices, and asking questions about experiences. Saldaña draws together the findings of many researchers who use coding to develop ways of organizing coding, mechanics and formats for coding, the types of analytic memos utilized, and the categories of First Cycle Coding, post-First Cycle Coding, Second Cycle Coding and final methods of analysis to develop themes. (Saldaña, 2014) These methods will be more fully explored in the next chapter, and connected with the investigation of CL and CTA in the complex classroom.

Moustakas (1994) modified van Kaam's (1959, 1966) method of phenomenological analysis, which provides a very detailed guide to phenomenological analysis and performs the phenomenological reduction with a rigorous method. The process begins with completely transcribed interviews of every participant, which include the notes and codes in the margins that indicate sections of the interview that are relevant to the experience being studied. This process is called horizonalization in the literature of phenomenology. Each expression of the experience is given equal weight and value and is considered a contribution to understanding the meaning of the phenomenon (Moustakas, 1994). The second step is reduction and elimination of items that do not meet the criteria of invariant constituents, meaning that the moment of the experience described communicates essential and necessary information for understanding it, and that the item is something that may be labeled. Overlapping, vague and repetitive expressions are also eliminated or given more exact descriptions. What are left are the horizons, the invariant constituents of the experience (Moustakas, 1994). These invariant constituents are then clustered into themes. Next the themes are taken through a validation process, where themes are evaluated according to whether they are explicitly given in the transcripts, or whether the theme is compatible with events reported in interviews; if there are no links, the theme is eliminated. With these newly validated themes, the researcher constructs a textural description (the what) of each individual participant's experience. This is an account that describes the essence of the experience, what happened, and includes examples that are drawn directly from transcripts (Cresswell, 1998). The feelings, thoughts, difficulties, relationships, situations, meanings and perspectives that the individual participant, this teacher, reports are articulated to describe the essence of the phenomenon. Lastly, a composite description of all of the participants' descriptions is developed by comparing the individual descriptions, expressing commonalities that represent the group as a whole (Moustakas, 1994).

Synthesis of Research Findings

CL is the number of non-automated responses required to solve a specific problem (Salomon, 1984). Nonautomated responses represent items that have not been chunked into schemas in long-term memory but are still a part of working memory. It is predictable that teachers have more access to these steps and that these items are the valid subjects of CL. When items are automated, the level of CL is diminished or non-existent, completely outside working memory. These are therefore difficult to measure in terms of memory capacity. Complex tasks involving multiple steps and interacting elements will increase CL, but the attribute of complexity may muddle the data, since teachers may not know how they do what they do, or may not care for the item at all.

The research literature associated with the theoretical construct, CL, have been explored in this literature review, and not the real, complex teacher experience of CL. Fluctuations of novice teachers' CL are not directly observable in teacher practice. But for the observer and interviewer, mental effort described in subjective reporting may be associated with empirical indicators of CL (Fawcett, 1997). Before CL occurs, there must first be an attempt to enact a task that involves non-automated cognitive processing. The experience of CL is not one of a mere mood or a feeling, but is the experience of one's working memory capacity in the enactment of a technique or task. The task is easily identified as the deliberate work of a teacher interacting with students toward a particular goal and is not random or accidental, but intentional. The theory of CL tries to account for behaviors of learners and the results of specific learning designs. Externally perceived and measured behaviors and results alone are not enough to account for the underlying construct, and so teachers must be asked directly to evaluate their internal experience of mental effort and the ways in which it manifests. Unique tasks of teaching in unique classroom environments align with unique levels of mental effort, which only an individual teacher can identify.

A researcher may pick a skill to study or a technique to observe, but ignore the amount of CL that makes transfer of these skills effective. For example, one may see a teacher execute a non-verbal redirection with a correct gesture. The fact that the gesture utterly diverts the teacher from other tasks by the gesture may be relevant to teacher support practices and effective intervention. The observer must understand the specific skill within the total complexity of skills, and how those skills relate to specific goals in the classroom environment, and the level of automaticity and load that apply to those skills and why these levels apply. It is easy for an expert coach to say that what he or she taught and observed was a valuable practice. It is much harder to describe the right way or the right order, or how the learning design for this teacher impacted her cognitive processes and novice teacher load.

Summary

Literature reviewed in this chapter included research on the theoretical constructs underlying CLT, the importance of CTA for understanding the elements of teacher practice and the categories that contribute or diminish CL, and the justification for utilizing Doug Lemov as an example of teacher observation and articulation of learning principles. Phenomenological research as it could relate to the study of CL was also examined, as well as coding methods that link teacher experiences with classroom practices, with a view to developing observation, interview and analysis methods. Understanding CLT, how the tools of CTA categorize elements of practice, and the complexity of the classroom and the tasks of teaching support the research design within the methodological section. Everyday experience is embedded with meanings given by individuals, and phenomenological description is concerned with these. Such description is not meant to establish cause and effect in teacher experience, nor does it attempt to create theory. (Horn, 1998) The study will remain empirical if the researcher interviews persons who are real about experiences that are real and gain data about real events, but the researcher will clarify the data with phenomenological analysis. (Englander, 2016)

The purpose of this phenomenological study is to gain insight into novice teachers' experiences of CL, the level of automaticity or the overload of teacher working memory. This will entail observation and interviews of both novice teachers and expert teacher-learning designers and analysis of the causes, signs and impact of CL on classroom practice and teacher learning design. Protocols for interviewing novice teachers and experts will be developed in the context of CTA and CLT that will assist in future teaching expertise transfer. This review also provided a comprehensive review of the methods of CTA and attempts to apply types of such analysis to the classroom. These methods and particular applications assist in the observation and codifying process and analytical categorizing of teacher experiences. Citing Bernard (2011), Saldaña (2013) affirms of analysis that it is a search for patterns and explanations of patterns, and that coding provides a method to organize data from experience that share the same characteristics. Studying expertise transfer and specific applications of such transfer to complex classrooms demands the language categories of CTA in order to deepen researcher perceptions, clarify observations, and provide linguistic categories. Although teacher preparation programs rarely use the findings of CLT (Feldon, 2007a), and there is a mysterious gap between CLT and classroom experiences and stories, analysis of CL will bring together the real phenomenon and proven frameworks of learning design. Cognitive psychology and more general theories of expertise offer a firm analysis of why novice teachers suffer from cognitive overload during instruction and why expert teachers demonstrate a facilitating automaticity (Moos & Pitton, 2014). This theoretical framework clarifies hierarchies of skills within the tasks of teaching and explains the impact of reduced and optimal learning designs on teacher cognitive processing. This conceptual framework will facilitate observations and interviews of teachers and coaches involved in teacher development, coaching, observation, and evaluation.

Chapter 3: Methodology

This is a study of the phenomenon CL as experienced and made meaningful by teachers in the classroom. To explore CL within the specific environment of the complex classroom means hearing stories and describing, with novice teachers, the dynamic relationship between the limits of working memory and their teacher training, performance, and preparation. A depthful understanding of the essence of this experience deepens understanding of teacher performance and support, and offers more effective protocols for novice teacher preparation (Feldon, 2007a). The literature review explored CLT and CTA as cognitive psychology's framework for designing expertise transfer. Most of the studies reviewed are based on research that compares one learning design against another to demonstrate a level of load and its impact, and theorize from this the types of load. This study examines teacher mental effort directly, through teacher stories. The review exposed how CLT and CTA are not utilized widely in teaching, but offered Lemov's example of learning design as a framework to explore CL and establish the relevance of mental workload for teacher expertise transfer. The literature review represented a first phenomenological epoché, a turn from more naturalistic approaches to teacher observation and learning design and a turn from problematic representations of teacher expertise. There is an everydayness to explanations of teacher practice that phenomenology may overcome, and the literature review provided an alternative perspective. However, a second epoché was necessary, an even more dramatic turn from all theoretical frameworks, to the prereflective, raw experience of mental workload in the complex life-world of the classroom. Life as teachers live it was the objective of this turn. (van Manen, 2014) This chapter presents the methods by which this turn was made, enabling a consideration of the phenomenon without the theoretical constructs that would solidify experiences into a category.

Research Questions

Research interviews are phenomenological when they recognize the transitory nature of human experiences, that understanding an experience (what it is) is entirely subjective, that lived experience is the foundation of the phenomenon, and that emphasizes meaning and the context of meaning (Seidman, 2013). Phenomenological questions are different from merely qualitative study questions, in that they strive for the essence of a prereflective experience. In the case of studying CL, this study cannot arrive at this by explaining the theory and asking teachers to share their opinions about it. The phenomenological question asks 'what is the experience' of the participant (van Manen, 2014) in order to get at the mental events and processes the subject is living through. The questions of this research, therefore, were phenomenological in that they were designed to elicit lived experience descriptions, the accounts of something a teacher lived through, to develop themes from this experience and to create composite structural and textural descriptions of this experience (Moustakas, 1994). The purpose of these phenomenological questions was for teachers to share the stories of what has happened, their cognitive processes, within the life-world of the classroom. (van Manen, 2014)

The purpose of this study was met by answering the following questions:

1. What is the experience that novice teachers have of different types and levels of mental effort in complex classroom environments?
2. How do novice teachers become aware of their own CL (i.e. emotions, student responses, confusion, frustration, self-concept, automaticity, efficiency)?
3. What do novice teachers experience as the consequences of different types of CL on their development of expertise?

4. How do novice teacher perceptions of CL provide insight, if any, about the relevance of specific learning designs for teacher expertise transfer?

Purpose and Design of the Study

The purpose of this phenomenological study was to explore the phenomenon CL through the lived experiences of novice teachers in the complex classroom environment. CL is a profound idea resistant to fuller understanding. Rich descriptions and insights regarding CL were reflectively exposed, and the experience and meaning appropriated new depth and greater relevancy for teacher learning design. Specifically, the study was focused on stories of teachers who practice recurrent classroom techniques and solve problems, and how their enactment impacted cognitive processes, teacher emotions, and ongoing development. Thematic reflections on the impact that CL has on novice teachers, as in teacher emotions, self-concept and motivation, overall practice, effectiveness in classroom management, and classroom instruction, could only arise from the original accounts. Based on these novice teacher accounts of prereflective experiences of CL, the study shed light on the relevance of specific learning designs for teacher expertise transfer.

A qualitative research design effectively located the researcher in the life-world of novice teachers and allowed exploration of their experiences of CL. Creswell (2007) reviewed five qualitative traditions: (a) narrative, which studies the life of an individual, (b) grounded theory, which develops theory based on field data, (c) case study, which develops in-depth descriptions of a program or activity, (d) ethnography, a study of a culture’s shared patterns, and (e) phenomenology, which understands the essence of an experience. Phenomenology emphasizes the phenomenon to be explored, which is expressed in a single concept or idea, such as a psychological concept. The exploration of the concept turns on individuals who share the same subjective experiences and the same life-world in which the experiences take place. According to Creswell (2007), phenomenology is most suitable for understanding the shared experience of individuals of a phenomenon. The ways that people understand and make meaning of a phenomenon experienced by them directly are suitably explored with phenomenology (Patton, 2002). Moreover, the development of practices and policies, such as those directing teacher learning design, may flow from a phenomenological understanding of the experience (Creswell, 2007).

The questions guiding this research were designed in order to capture the investigation into the experiences of novice teachers in the complex classroom as these may be directly associated with the phenomena of CL. This study of novice perceptions was exploratory, as there has been little research into novice teacher classroom experience of CL and the phenomenon as experienced in complex classrooms is not completely understood.

While this study arose from the researcher's own experience of novice teacher development and from particular theoretical (CLT) and practical (CTA) approaches to expertise transfer, the phenomenological attitude demanded that the researcher create a space where teachers could share their experiences and stories regarding their own practice and the experience of mental workload in the complex classroom. The eidetic reduction of these experiences involved a new stage of grasping essential insights as the meaning of a CL event was tested; varying aspects of CL through imaginative variation and comparing empirical examples did this, until the imagined or empirical variation would "destroy or change the phenomenon into something else" (van Manen, 2014, p. 228). Phenomenology does not merely repeat experiences, but discovers their eidetic structures and internal meaning, their essence. Something actually happens and the description of what happens "reawakens, evokes or shows us reflectively the lived meaning and significance of the prerefective experience… in a fuller or deeper manner" (van Manen, 2014, p. 229). The eidos of CL did not simplify or contract the concept, but enriched it through the process of interpretation and analysis. Qualitative research is descriptive and interpretive, and the method used here involved the coding of novice teacher responses by the researcher and interpretation by the researcher (Miles, Huberman, & Saldaña, 2014). Since the participants' experiences were situated in relationship to the researcher, the goal of the researcher was to provide both the presence of participants and to acknowledge the influences upon the interpreting researcher (Goodley, Lawthom, Clough, & Moore, 2004).

The specific design of the research included three steps: (1) gathering data through observing and interviewing, (2) coding and horizonalizing this data, and (3) thematic analysis of data to arrive at the essence of an experience. For gathering data, specifically through interviewing, Seidman's (2013) three-interview format informed the interview process, as well as van Manen's (2014) approach to gathering empirical data through the phenomenological interview and observing lived experience. From observation and interview processes, memos, audio recordings and detailed transcriptions of teacher experience were produced. The analysis of data utilized Moustakas' (1994) modification of van Kaam's (1959, 1966) method of analyzing data; however, other phenomenological research designs elaborated this approach. van Manen proposes a hermeneutic interview as a way of interpreting data, and this research drew on Saldaña's (2014) methods of First-Cycle coding of teacher responses to interact with transcriptions and arrive at the essence of the experience; this coding of transcriptions of teacher experiences represented the horizonalizing of the data. In thematic analysis, Moustakas (1994) describes how the researcher performed reduction and elimination of items that were not invariant constituents, clustered these into themes, validation of themes, the construction of textural and structural descriptions of each teacher's experience, and the final composite description that resulted from comparison of teacher experiences. Second-Cycle coding methods (Miles, Huberman, & Saldaña, 2014; Saldaña, 2014), along with methods of exploring, describing, ordering and explaining data were integrated into these final processes. Table 1 provides a thorough outline and index of methods and actions that were applied.

Table 1

Phenomenological Methods and Researcher Actions

Gathering Data	Researcher Actions
Formulating the question (Moustakas, 1994, p. 104)	Phenomenological questions grew from intense interest in the impact of cognitive load on teaching and learning design and a desire to explore the lived experience of educators, according to Moustakas' five criteria (1994, p. 105)
Review literature (Moustakas, 1994, p. 111)	Assessed relevant studies to integrate knowledge and analyze theories of phenomenon. CTA and teacher learning taxonomy studies demonstrate relevance of the phenomenon in teacher learning. Understanding of fluctuation of load and teacher cognitive processes is deficient.
Develop criteria for sample	Criterion sampling for novice teachers (with under two years of classroom experience). As form of convenience sampling, 40 participants were targeted with an email (see Appendix B) and 6 responded, with 6 accepting and signing the consent form (see Appendix C). Both forms will be approved through the IRB (see Appendix C)

(continued)

Gathering Data	Researcher Actions
Develop participant instructions, observation protocols and open, guiding questions for phenomenological interviews (Moustakas, 1994, p. 114; Seidman, 2013; van Manen, 2014)	The interview guide (see Appendix A) (Instrumentation) ensured that guiding questions were asked of all participants, recognizing the difficulty of eliciting pre-reflective experiences, avoiding questions about an experience and focusing on what living through the experience was like. Per van Manen (2014, p. 316) illustrations/examples of mental effort were utilized for a nurse, air traffic controller, platoon commander to deepen reflection on the classroom context of the experience.
Develop Data Management (Miles, Huberman, Saldaña, 2014, p. 46–51)	The researcher evaluated CAQDAS (Computer Assisted Qualitative Data Analysis Software) and chose *Atlas.ti*; developed data management and retention strategies, including raw materials, recordings, memos, transcriptions, coded data, codebook, reflections on conceptual meanings, search records for retrieved chunks of data, data displays, analysis episodes, chronological logs and indexes
Epoche process sets aside past associations, understandings, biases and the natural attitude to teacher experiences; bracketing the question	The researcher identified biases related to observation and evaluation, defined categories of effectiveness and expert performance. An observation and conversation animated by wonder and openness focused on emergence of stories. Each teacher was recognized as a microcosm of possibilities. Coding included Bracket Coding and Reflexive Coding of transcripts, making the researcher also a subject of study and identifying bias and presumptions.
Qualitative interviews and observations (Seidman, 2013)	Three interviews and one observation were given for participants at convenient locations and times. "Focused Life History" gave an introduction, instructions, signing of assent form (See Appendix C), then allowed participants to reconstruct experiences of learning to teach and favorite / least favorite recurrent classroom practices. Most importantly, items of teaching that the participant was currently practicing and will demonstrate in observation were isolated.

(continued)

Gathering Data	Researcher Actions
	Observation followed this interview and preceded "Details of Experience" interview. This interview elicited pre-reflective experiences associated with cognitive load. A final "Reflection on the Meaning" interview explored the meaning teachers give both the experience and their learning development in a larger context. Final transcriptions (pdfs) were made utilizing TranscribeMe (with confidentiality assurances) and sent to the participant for confirmation and accuracy, and responsive comments recorded.
Analysis concurrent with data collection (Miles, Huberman, Saldaña, 2014, p. 70)	The researcher developed field notes and analytic memos as the interviews progressed, exploring the experience with teachers.

Coding and Horizonalizing	Researcher Actions
First Cycle Coding (Miles, Huberman, Saldaña, 2014; Saldaña, 2014)	Detailed transcriptions of interviews and observation notes were developed in special format for coding purposes. Coding as a heuristic was applied, utilizing different types of coding and coding processes, including descriptive, In Vivo, taxonomic, emotion, process, values, evaluation, causation, protocol, magnitude, etc. Codes were developed inductively for teaching events and classroom interactions and processes, and codes were recorded with operational definitions.
Horizonalization gives equal worth and weight to every expression relevant to the experience (Moustakas, 1994, p. 120)	The researcher highlighted sections of transcripts relevant to the experience of cognitive load, and developed a list of non-repetitive, non-overlapping statements.
Reduction and elimination (Moustakas, 1994, p. 121)	The researcher tested each expression in the individual transcripts for whether it contained a component vital to understanding cognitive load, and if it could be labeled. Such expressions were horizons of the experience. The results of this process will be invariant constituents.

(continued)

Thematic Analysis	Researcher Actions
Clustering and thematizing (Moustakas, 1994, p. 121), with Cycle 2 Coding (Miles, Huberman, Saldaña, 2014; Saldaña, 2014)	The researcher clustered the related invariant constituents into themes and meaning units and labeled them; these formed the core themes of the experience. Pattern coding was utilized to create a smaller number of categories, themes, and constructs. Emergent themes were identified through explanatory or inferential codes. Pattern codes were developed through analytic memos and emergent themes.
Validation by application of invariant constituents and themes to transcriptions (Moustakas, 1994, p. 121)	The researcher tested invariant constituents and themes against the participant's transcripts; items explicitly expressed or compatible with the expression or theme were validated and included.
Construct an individual textural description of the experience (Moustakas, 1994, p. 121; Creswell, 2013, pp. 193–194)	For each individual participant, the researcher constructed a textural description (a description of the what or essence of the experience) that included verbatim anecdotes from the interviews.
Construct an individual structural description of the experience (Moustakas, 1994, p. 121: Creswell, 2013, p. 193–194)	For each individual participant, the researcher used imaginative variation and the individual textural description to construct an individual structural description, the how of the experience, which includes the setting and context in which the experience happened.
Develop a composite description of the meanings and essences of the experience from the individual textural–structural descriptions, representing the entire group (Moustakas, 1994, p. 121: Creswell, 2013, pp. 193–194)	The researcher developed a unified description of cognitive load as experienced by teachers in the complex classroom, the essence of the experience.

Summary and Outcomes	Researcher Actions
Study summary	The researcher summarized the findings regarding the phenomenon cognitive load.
Compare and contrast the study with the research described in the literature review	The researcher compared the findings of the literature review with those of the study, exploring how the application of phenomenology elaborated research on cognitive load and teacher learning design, the depth-dimension to which this study contributes.

(continued)

Summary and Outcomes	Researcher Actions
Explore possible impact of the study on future learning design models for teachers	The researcher explored how the findings may impact teacher learning design and expertise transfer and made recommendations for future research related to cognitive load and teacher learning.

Research Population and Sampling Method

The goal of this phenomenological research was to approach as near as possible a novice teacher's lived experiences. "Lived experience means that phenomenology reflects on the prereflective or prepredicative life of human existence as living through it" (van Manen, 2014, p. 26). In-depth phenomenological interviews engaged participants who were currently living through those experiences in the context of the complex environment (Seidman, 2013). Typically, phenomenological studies have a reduced number of participants, and sample sizes may range from 6 to 10 participants (Teddlie & Tashakkori, 2009), to 12 participants (Guest, Bunce, & Johnson, 2006), to 5 to 25 participants (Miller & Salkind, 2002). Novice teachers were affiliated with two large urban districts in the Northwest United States. Those districts employed 40 novice teachers as of August 2017. Purposeful strategies for sampling accept that researchers have a basic understanding of the phenomenon to be studied and are searching for a group that will represent experiences of the phenomenon; Creswell (2013) indicated that a phenomenological study requires that the participants share such experiences. A purposeful sampling strategy used in this study was criterion sampling (Patton, 2002). Merriam (1998) indicated why researchers should carefully describe the criteria framing a sample selection, and how that selection aligns with the purpose of the study. The criteria for novice teacher participation were novice teachers having spent less than two years in an actual classroom. Teachers were chosen because of their limited experience with the belief that they would be in the learning process and had access to the experience of CL. It was also assumed that teachers belonging to the classroom as a complex learning environment would be engaged in informal forms of complex learning to acquire new skills. It was expected that novices with less time in the classroom would have increased likelihood for higher levels of CL experienced. As a form of convenience sampling (Patton, 2002), emails were sent through the District offices to all those meeting the criteria. The email informed students of the nature of the study, and asked them to make contact with the researcher if they wished to participate, and described the conditions of participation and confidentiality procedures. A total of 6 potential participants responded to the invitation. They received a reply which thanked them for their participation and set a date for the initial interview, observation and the second interview.

Instrumentation

For Seidman (2013), the instrument is the human interview, and the researcher's focus was on designing a meaningful interaction with an interview and observation protocol as a guide. This instrument affected the process, and the meaning drawn out from participants was a function of their interaction; interactions were designed to affirm and validate the participant. Methods chosen for phenomenological study were able to draw out diverse experiences, and this study utilized a phenomenological interview methodology. The purpose of the interview was not to test a theoretical hypothesis or to evaluate a person or program, but to come to understand the lived experience of a person and what that experience meant to them. (Pollio, et al., 1997; Seidman, 2013). Semi-structured interviews were steered by an observation and interview protocol (see Appendix A) that included primary questions and then possible follow up questions that helped to answer the research questions of this study (Creswell, 2003; Rubin & Rubin, 2005; Warren, 2002). The primary questions provided a framework to address the major research questions, and follow-up questions obtained greater detail. The interview protocol was designed to elicit the prereflective experience of teachers, following van Manen's (2014) and Seidman's (2013) recommendations: the interview did not aim for interpretations about CL or its theory, but instead encouraged novices to share their stories, exploring their own complex cognitive processes in the classroom and the mental workload associated with these. The inclusion of the observation protocol between the first and second interviews provided a tool and data that focused the conversations with teachers in the classroom who were attempting new skills and techniques, as they underwent CL. At the end of the first interview, teachers were encouraged to develop a skill or technique during the classroom observation, and this activity offered pivotal events for discussion in the final two interviews.

The instrument should be considered a valid elicitor of teacher CL experiences in that it was focused on the prereflective experience in the context of learning within the complex classroom, and because the question structure and language drew out the accounts. Validity of the questions was also tested, after the coding process, by comparing the invariant constituents of the phenomenon with the actual transcriptions to test if teacher experiences were accurately represented. A dissertation committee examined the first version of the interview protocol and gave feedback about the questions and whether they address the research questions, and the interview was amended. (Flick, 2007; Rubin & Rubin, 2005)

Novice teachers were contacted by email to set up a time for the interviews and the observation. At the first interview, the participants reviewed and signed an informed consent form approved by the Concordia University–Portland Institutional Review Board to acknowledge their voluntary participation in the research. Participants' names were associated with an alias list and their names and contact information stored in the computer of the researcher's home office for the sake of guarding their confidentiality.

Data Collection

Qualitative interviewing involved a constant process of reflection in which the researcher examined himself and the research relationship, identifying preconceptions and theoretical frameworks and how these assumptions impacted research and the selection of wording during questioning. Researchers carry conceptual baggage (Kirby & McKenna, 1989) that must be examined, including conceptual assumptions. At the core of reflexivity discussions was analysis of how the researcher and the participant developed a relationship that impacted or even distorted analysis (Simbürger, 2014). In other words, the researcher had a way of looking at teacher practice and learning and this way of looking at things was different than that of the participant, and, since the researcher framed the discussion, the framing needed to be studied. In the selection of a problem, the composition of hypotheses, and in choices of conceptual framing, exposing a certain value system is unavoidable (Simürger, 2014). The researcher positioned himself below, making his positions explicit and exposing his own experiences with the phenomenon in work, school, and teaching, and revealed how these experiences impacted his interpretation of the phenomenon (Creswell, 2013). The researcher could not assume that, in collecting data through interviews, the truth about CL would be discovered by the right questions; nor could the researcher claim to be totally objective in questions, or that answers should propose a single reality. In the use of the interview guide, the researcher avoided manipulation of participants by demanding responses, and did not impose his own interests on the reconstructions of the participants (Seidman, 2013).

Phenomenology was designed to overcome researcher assumptions and to return to the pure phenomena, outside of theoretical or philosophical presumptions and the experience of the researcher, to get "Back to the things themselves!" (Moustakas, 1994, p. 26). The phenomenologist brackets himself or herself from the study by exposing experiences with the phenomena or exposing theoretical assumptions regarding a phenomenon, giving their position (Creswell, 2013). As discussed in the review, bracketing does not mean forgetting experiences or pretending one has no assumptions, but means that as one experiences others, those assumptions are brought to light and separated. Phenomenologists are not detached from presumptions and do not pretend detachment (Hammersley, 2000). Among qualitative studies, phenomenology also has its own validation criteria. van Manen (2014) asserted that this validity is based on the validity of the phenomenological question itself. This study asked, "What is this human experience like?" or "how is it experienced?" It did not deal with causal explanation, as CL studies do. It did not work toward theoretical explanations, as cognitive psychologists construct. It was based on experientially descriptive accounts, and not merely perceptions, opinions and beliefs (although teachers described and gave accounts of their perceptions, opinions and beliefs). Finally, the interview was based on phenomenological principles of inquiry (Pollio, et al., 1997; Seidman, 2013), and not those of cognitive psychology sources, although these tertiary sources could be confirmed in the experience of novices. Since questions of reliability have to do with repeatability in terms of measurement, van Manen (2014) dismissed it as a goal since phenomenological studies are unique and strive for new insight regarding the same phenomenon.

The element of wonder dominated conversations with teachers. The meaning each teacher gave to an experience was constructed by that teacher. Although the theoretical concept CL provided the researcher a target, the researcher created the space for teachers to explore the mental limits they met in the classroom, to describe the complexity of decisions and actions, and to reveal the experience of their problem-solving, efforts-to-learn and acquisition of expertise.

Going into the interview, the researcher was aware of the lens by which he views teaching, cognitive learning design, and of his own well-confirmed history and experiences of novice teacher frustration and needs but also was aware that the reality to be explored was more profound and complex than his single view could grasp. The interviewer expressed an authentic wonder and awe at the challenges of teaching and its complexity. The interview avoided yes / no answers, and sensitively avoided the question, “Why?” as such questions are indicative of non-reflexive bias. The study remained empirical in that real events in real situations led to the sharing of real experiences. When teachers dismissed questions or considered them irrelevant or difficult, the dismissal was accepted. Assumptions of CL were present (for that is the phenomenon in focus), but queries utilized everyday language regarding classroom events, complexity, effortful and effortless practice, and mental processing. The language of cognitive psychology was avoided during interviews, and the most basic classroom terms were utilized. Even language regarding dual-process models of thinking, while at times indicated, was mostly avoided, as well as technical language of CTA, other than the term recurrent, which was be used in an everyday sense describing classroom challenges (Hsuing, 2008). The interview was reflexive because the researcher bracketed presumptions, and the questions served as a context for teachers to explore prereflective experiences.

While each interview was unique, the protocol guided the conversation. This protocol (see Appendix A) was based on Seidman’s combination of life-history conversations and interviews that draw out details of the experience. The three-interview structure helped the researcher and the participants give a context for the phenomenon of CL as it occured in different teacher learning contexts. The interviews happened in close proximity to the observation, so that events observed were remembered by the teacher. Each interview lasted no longer than ninety minutes, per Seidman's (2013) recommendations. The "Focused Life History" interview explored teacher learning experiences prior to the classroom, how that complex environment impacted their learning, and their learning goals within the classroom. At the end of this first interview, teachers were asked to prepare a learning item for the researcher to observe and an observation was scheduled. The observation protocol was "clinical" in an educational or administrative sense, in that all events and interactions were recorded and given equal weight. The researcher watched for the isolated skills to be observed, signs of distress or frustration or a break in the novice teacher's flow, and took note of apparent indicators of fluctuations in mental workload. The researcher made field notes and memos of this observation, and referenced these in the second interview. In the second interview, "Details of Your Experience of Mental Effort in the Classroom", the researcher asked questions that brought out the prereflective experience. The third interview, "Reflections on the Meaning", located the experience in the context of teacher learning as a whole and in the complex classroom, allowing the teacher to explore the meaning of mental effort and how it might help or hinder learning. Teachers were asked questions regarding the effects of their own CL, and questions about preferred learning design. During the interview, the participants also were given examples of highly complex environments and the people who respond and learn in these, and examples of expertise in such environments to help focus discussion of their own pereptions of expertise, their complex learning environment and how they interact within it.

When interviews were completed, word-for-word transcriptions were prepared from audio recordings. One interview was transcribed by the researcher and the rest were sent to TranscribeMe, with audio metrics applied. These transcriptions were sent in pdf format to participants for their responses.

Data Analysis Procedures

Transcripts were written from audio recordings of the three interviews. The transcripts were uploaded into Atlas.ti (Saldaña, 2014, p. 17), maintaining a format that allows the introduction of First Cycle Coding phrases. Transcripts served as the raw material for analysis, along with relevant memos and field notes. This material was saved for the later validation phases of the study, where the researcher compared themes to the real accounts of experiences given by teachers.

The analysis utilized an adapted version of Moustakas' (1994) modification of van Kaam's (1959, 1966) method to perform the phenomenological reduction. The process began with completely transcribed interviews of every participant, which included the First Cycle Coding (Miles, Huberman, & Saldaña, 2014; Saldaña, 2014) and notes in the margins that indicated sections of the interview that were relevant to instances of CL. This process is called horizonalization in the literature of phenomenology. Each expression of the experience was considered of equal worth as a contribution to understanding the meaning of the phenomenon. (Moustakas, 1994)

In order to facilitate horizonalization and the next steps given by Moustakas (1994), a rigorous coding process was introduced, with procedures developed by Saldaña (Miles, Huberman, & Saldaña, 2014; Saldaña, 2014) in order to help identify the relevant expressions and categorize invariant constituents. Codes are "essence-capturing" (Saldaña, 2014, p. 8) and both elaborated and facilitated the Moustakas (1994) development of invariant constituents and themes. The researcher systematically labeled expressions by types by assigning codes to specific phrases or experiences. (Miles, Huberman, & Saldaña, 2014). Codes were applied to data in order to segregate the data, group it and regroup it to consolidate meanings (Saldaña, 2014). The researcher identified patterns and attempted explanations of patterns, and the coding offered a method to organize data from teacher experience that shared the same characteristics. This process was heuristic, a way of discovery and exploration that linked the empirical data to ideas and ideas to the data. As codes were applied and reapplied to data, segregated and relinked, this process consolidated meanings and explanations associated with the data and helped patterns to emerge. Explorations of CLT and CTA as well as Lemov's taxonomy and models of teacher learning design provided a framework and focus for coding teacher practices and descriptions, and asked for questions about experiences.

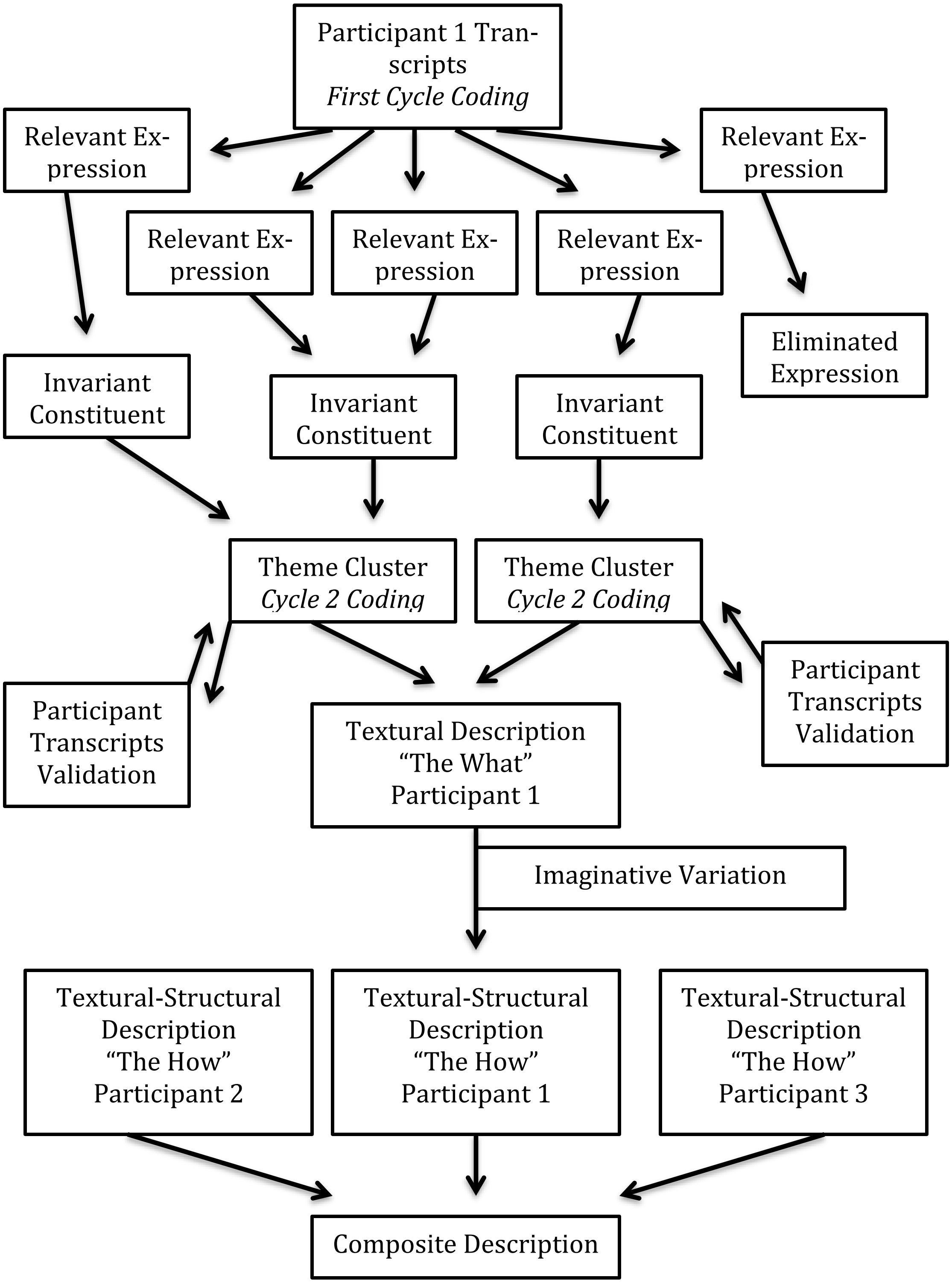

Figure 1. Moustakas' (1994) application of the van Kaam (1959. 1966) method of phenomenological analysis, with First Cycle and Second Cycle Coding of Saldaña (2014) integrated.

Saldaña drew together the findings of many researchers who use coding to develop ways of organizing coding, mechanics and formats for coding, the types of analytic memos utilized, and the categories of First Cycle Coding. Saldaña (2014) proposed that the coding method designed for a study depends on the research question, and codes also must harmonize with the theoretical and epistemological framework. The author offered 32 different methods of coding, but the analytic approach must be as unique as each study. In this study of the experience of teachers, questions revolved around teaching in the classroom and its complex interactions and also the subjectively experienced phenomenon of teacher cognition; in this case In Vivo coding, which utilizes the direct language of participants as codes, honored the voices of teachers rather than the language of the researcher (Saldaña, 2014, p. 61). Table 2 lists the types of coding utilized in this study, the rationale for use in this study, and describes the most relevant interview (or observation) for application.

Table 2

Saldaña's (2014) Coding Methods Utilized in This Study

Coding Methods	Rationale	Relevant Interview
First Cycle Coding Methods		
1. Attribute Coding logs demographic and site information, date and time, and media utilized for data management reasons; used in most qualitative studies for basic identifying data (p. 69)	Specific teacher backgrounds, class sizes, subjects and experience are recorded	All
2. Magnitude Coding registers intensity, frequency, presence, direction, and may be quantitative (p. 72) e.g., High>Medium>Low>None e.g., Present; Absent; Unclear	Levels of working memory effort, capacity of working memory in specific tasks, recurrence of techniques and level of automaticity require	All, Especially Obs. & 2nd

(continued)

Coding Methods	Rationale	Relevant Interview
e.g., Conscious>Semi-conscious>Unconscious e.g., Nascent>Intrinsic>Germane (Flow to long-term memory)	quantification; register size of working memory item / process; level of complexity of classroom interactions needs valuation	
3. Subcoding is a type of secondary coding used to classify codes that are too broad (p. 77)	Size of teacher task may require sub-tasks and sub-processes	All
4. Simultaneous Coding applies two different codes to one qualitative item, overlapping analysis (p. 80)	Variant aspects of teacher experiences may require different codes, as in emotion with cognitive flow	All
5. Structural Coding applies content-based or conceptual phrases that relate to a specific research question (p. 84)	Germane, intrinsic, or extraneous loads may apply; performance (drawing from schemas) vs. informance (adding schemas)	All
6. Descriptive Coding brings a passage of qualitative data together in one word or phrase, the basic vocabulary of the data (p. 87)	Large sections of accounts or stories may be classified under a single word	All
7. In Vivo Coding utilizes the words of the subjects interviewed, honoring the participant's voice, and allowing a culture or group to speak (p. 91)	Phenomenological openness honors perspective of teacher culture, language and experience	All
8. Process Coding applies gerunds (-ing words) to represent action in the data and study the processes of human action; useful for search of ongoing action, interaction or emotion (p. 96)	Cognitive load occurs in a process of classroom actions, in the interactions and decisions of teachers; teachers will be in a process of telling stories and experiences throughout	Obs. & 2nd, and to register process of storytelling for All
9. Emotion Coding labels emotions of participants that are recalled or experienced during interviewing; can use in vivo codes for reactions (p. 105)	Teacher feelings may be secondary attributes of mental workload, automaticity and cognitive overload	All

(continued)

Coding Methods	Rationale	Relevant Interview
10. Values Coding reflect the participants attitudes and beliefs, how they represent their perspective (p. 110)	In Focused Life History and Reflection on Meaning, teachers contextualize their experience according to values and attitudes	1st & 3rd
11. Taxonomic Coding is a very specialized form of ethnographic coding, discovers cultural knowledge that organizes behaviors and interprets action. Domains of practice contain hierarchical lists to be classified as taxonomy (p. 157)	Has analogies to the types of categories used in CTA, analyzing tasks and subtasks of teaching; the teacher's own domains and taxonomy as described by them will be unique, and hierarchically ordered	All
12. Causation Coding identifies causes, outcomes and links causes and outcomes in the grammar of a participant's story; dimensions of causality are internal/external, stable/unstable, personal/universal and controllable/uncontrollable (p. 163)	Causes of cognitive processes will be multiple; levels of cognitive load may result from rich schemas vs. poor schemas, variability of a skill's complexity vs. environmental factors, caprice vs. practiced skill	All
Second Cycle Coding Methods		
1. Axial Coding determines dominant codes according to the category, which serves as an Axis (p. 218)	In this the case of this study: increased or decreased cognitive load	All
2. Elaborative Coding analyzes text to develop theory further; utilizing prior theory, new constructs emerge from themes and are grouped together as categories (p. 229)	Cognitive Load Theory is elaborated from the different perspectives offered by teachers and enriched	All

Note. Actual codes utilized will be presented in the Data Analysis (Chapter 4).

Along with the coding methods given above, Saldaña wrote about "the coded researcher" (2014, p. 16), describing how the exchanges between participant and researcher should both be coded.

Since in phenomenological studies the researcher must bracket his or her presumptions and attitudes, and interviews were reflexive and not dominated by the researcher, Bracket Codes or Reflexive Codes also were developed to critique and supplement the researcher's position.

Following Moustakas (1994), the second step was reduction and elimination of items that did not meet the criteria of invariant constituents, meaning that the moment of the experience described communicated essential and necessary information for understanding it, and that the item was something that could be labeled. Overlapping, vague and repetitive expressions were eliminated or given more exact descriptions. What was left were the horizons, the invariant constituents of the experience. These invariant constituents were clustered into themes (Moustakas, 1994). Second Cycle Coding was introduced (Saldaña, 2014) and applied to these invariant constituents and to the codes that categorized and symbolized them. Codes and categories emerged and patterns emerged, separate cycles of coding refined perspectives, until, after re-coding and re-categorizing the data, the categories began to transcend the reality given in the raw data and became thematic (Saldaña, 2014).

The themes were taken through a validation process, where themes were evaluated according to whether they were explicitly given in the transcripts, or whether the theme was compatible with events reported in interviews; if there were no links, the theme was eliminated. With these newly validated themes, the researcher constructed a textural description, the *what* of each individual participant's experience. This were accounts that described the essence of the experience, what happened, and included examples that were drawn directly from transcripts (Creswell, 1998). The feelings, thoughts, difficulties, relationships, situations, meanings and perspectives that the individual participant reported were articulated to describe the essence of the phenomenon.

Imaginative Variation followed the process of phenomenological reduction, and possible meanings were developed through varying frames of reference, utilizing polarities and reversals, and looking at the phenomenon from different angles, roles and functions. Structural descriptions arose from this process, to identify underlying factors that explain what was experienced, how the experience happened. The coding process itself contributed to this variation, and connected the transcribed experiences with the essential structures. Themes and concepts became sassertions when raw data was translated in the coding process (Saldaña, 2014). From these essential structural descriptions of individual participant experiences, a composite description of all of the participants' descriptions was developed by comparing the individual descriptions, expressing commonalities that represented the group as a whole (Moustakas, 1994).

Delimitations and Limitations

Transparency should be the intention of any phenomenological researcher, as well as contextual information that might relate to data interpretation (Flick, 2007). The following biographical information is meant to position the researcher and assist with bracketing his natural attitude and theoretical framework. The researcher is a former inner-city teacher and principal, who came from a family of public and private school teachers. As a teacher, the researcher was placed in some very complex and volatile classroom environments and given very little support, and was forced to develop techniques and practices alone. During the early course of teaching drawing, painting and various language arts courses, the researcher mastered many techniques through observation of other teachers, teacher literature and experimentation.

While a principal for 10 years in a large urban school, the researcher constantly searched for resources that would support novice and veteran teachers in complex classrooms and developed observation and evaluation protocols that would be supportive of teachers. While celebrating that each teacher is unique and marveling at the diversity of different styles and methods of instruction to meet the same goals, the researcher also discovered the endemic goals of classrooms, and sought techniques of meeting recurrent issues in order to support a diverse staff. In 2010, the researcher read about Doug Lemov's (2010) taxonomy, contained in the first edition of Teach Like a Champion, and began reviewing techniques with teachers. A 2-week preservice summer training developed teacher skills for the following four years, and utilized Lemov, Woolway and Yezzi's *Practice Perfect*. The researcher's faculty responded positively to the approach of practicing select skills to automaticity. During this time, the researcher marveled at expert practice performance in the classroom, especially in teachers who demonstrated a facilitating automaticity. He also refined his own skills in support of novice teachers.

During doctoral studies, the researcher studied the work of David Feldon (2007a), one of the more specialized practitioners of CTA to study expert teaching, the complex classroom and automaticity. This led to further studies of the theoretical framework, CLT. This framework provided a bridge from the science of teaching in graduate studies to the practical application in the classroom, and seemed a plausible explanation for novice teacher difficulties as experienced by the researcher. The researcher studied learning designs that leave novice teachers to pick up the pieces of their own practice, and experienced the lack of happiness in the classroom that comes from non- supportive practices. Priorities for learning design began to shift due to these studies and the 10 years of experience as a Principal.

The researcher has a Bachelor of Arts degree in philosophy and 30 years of studying philosophical and hermeneutic phenomenology. The choice of phenomenology, while driven by the research question, will utilize the researcher's experience of listening to teachers and navigating with them the challenges of the classroom. Teachers are all unique in the ways that they conduct the symphony of minds that is the classroom, and embody the highest human aspirations in their hope for students; the researcher realizes that this statement may sound idealistic. But after working for 15 years in some of the most economically challenged and racially diverse schools in his large home city, and supporting the work of many dozens of teachers, this belief has remained a constant and has been confirmed for him again and again. It is the presumption of the researcher that novice teacher minds, their cognitive processes, are where real teacher learning does happen, and that these hidden places of work provide the most relevant information for teacher development. The researcher is further disheartened by what passes for expertise transfer in the schools he has experienced, and in the literature of teacher practice. Current evaluative and prescriptive solutions focus on external performance and student outcomes instead of mental informances, what goes on inside of a teacher in terms of acquiring what will make his or her job easier, moving practices from working memory to long term memory to create a flow that meets daily challenges and, ultimately, leads to satisfaction each day. Novice teachers are given initiatives and self-reflection exercises by experts, who are often unconscious or uninterested in the subtasks that support all masterful teaching. Novice teachers are judged for what is exteriorly enacted without reference to the stories and events within them that would throw light on their true needs. Many young teachers see their dreams of being masterful teachers dying from within, without anyone knowing what goes on inside, and are not given the tools or the learning framework to describe it themselves. The choice of phenomenological interview as a methodology is meant to honor the voices of novice teachers, and reflects the researcher's openness to exploring the essence of their greatest challenges with them.

The researcher represents the first limitation to be overcome in this study. Neutrality in any interpretation of teacher experiences or in any qualitative research process is not possible. This researcher's own experience of moving through complex classrooms from preservice to novitiate to any level of expertise impacts his interpretation. Professional development frameworks and theories practiced as a teacher coach and principal impact interpretation. It is impossible to suspend these experiences and the process of bracketing presumptions should compose an arduous exposition of assumptions as interpretation begins, from the first moment of the first interview.

Expert coaches and teachers are completely fallible, as are all programs of teacher support, and every novice teacher is in one. As demonstrated in the literature review, there is a wide body of research that indicates how experts, seeking to transfer their expertise, are often unable to identify the automated elements of their own practice that drive their own success. The social, cultural, economical, and education experiences of teachers and coaches also impact the meaning they give to events in their own practice. One goal of this research included an effort to strip the goals of expert programs of their power and influence on valuations of practices, and to consider the actual subjective experience voiced by teachers who themselves gave meaning to the moments of navigating classroom management and instructional complexities. Descriptions of the complex performances that teaching represents have been, for the most part, left in the hands of experts who control the conversation about practice. This research assumes, and has given justifications in the literature review, that this approach has disabled teaching. New ways of listening to novice teachers, new protocols of interviewing teachers that support their work, are required for better teacher support. While CTA practitioners have tools to elucidate the gaps in expert knowledge and deficiencies in learning design, novices have the experiences that meet the same goal from a different angle.

Another area of limitation had to do with the teacher's own history of development, how he or she had acquired the craft. The sources of teacher learning may be the childhood experiences of their own teachers, the preservice university classroom and the complex, real-life classroom. This study assumed that the complex classroom was the setting in which a novice experienced the most relevant levels of CL, due to the way CTA practitioners consider complex environments, real-life settings of complex learning, and the phenomena of CLT. The researcher assumed that the teaching mind is impacted by the dual process models of memory, and that CL or mental workload was a tangible phenomenon. This exploration strove to suspend explanations and predictions developed by separate studies, and allowed novice teacher voices and expert coaches' voices to be heard. As far as possible, the researcher coded observations and meaning-giving explanations of subjects in a language dissimilar from established theories, either from discovery education or CTA.

This research assumed that novice teachers would be honest and forthright regarding their experience of mental workload and possible frustrations regarding their practice. However, educators and support personnel are constantly being evaluated, and are always evaluating their own successes and failures, and each individual educator looks at their own data and practice differently, some with greater insecurity and self-consciousness and some with less. Questions regarding their frustrations or inability to respond to higher levels of CL could have created defensiveness and possible distortions of experience. However, the researcher observing and interviewing novice teachers provided both a secure environment for sharing and developed a relationship of trust.

The mental processes developed by teachers within the complex classroom are not only relevant to teacher development, these may well be its entirety. The emotions of teachers, and not just distant external evaluations of activities or achievement data, are relevant for novice learning design. An expert teacher or principal who observes a novice teacher may be completely absorbed with what is going on in his or her own mind, what he or she would do or think in a classroom, and never glimpse or even consider, with the novice teacher, what is actually happening within the latter's mind and heart. Their emotions are often direct responses to cognitive processes, wherein each step in reaching a classroom goal has a particular weight, sometimes an overwhelming weight, and the journey through the classroom can impact learning more than the best textbook description. This study paid attention to a particular type of weight or load in the minds of novice teachers. How the researcher would teach a class or what choices he feels should be made did not matter in observation and interviews, only the manner in which the novice teacher made choices and acted and how he or she gave a measure and meaning to this experience.

Validation

Phenomenological themes are functions of interpretation, and the researcher provided a program of understanding appropriate to the participant perspectives, a descriptive understanding. Pollio, Henley and Thompson (1997) proposed, citing Giorgi (1975), that the reader of a phenomenological study should be able to adopt the viewpoint of the researcher and see the same things that the researcher saw, just as that researcher saw them, whether or not he or she agrees. Textual evidence (the actual descriptions of teachers) supports interpretation. However, they also affirm that this goal can be adapted to fit specific research and may have interpretive goals:

For purposes of phenomenological interpretation, the criterion of validity becomes

> whether a reader, adopting the world view articulated by the researcher, would be able to see textual evidence supporting the interpretation, and whether the goal of providing a first-person understanding was attained. (Pollio, et al., 1997, p. 53)

While this research depended on the life-experiences of teachers for every conclusion, it assumed that CLT and CTA provided interpretive coding and a framework for analysis. Why is this nuance important? On one hand, the phenomenologist must create the conditions that allow the participant's voice to be heard, bracketing a theoretical framework and their own natural way of seeing teaching, and this was non-negotiable. On the other hand, novice teacher experiences were also filtered through constructivism, through possible ignorance of their own cognitive architecture, and a lack of understanding of how to optimize their own learning. For example, what if a teacher expressed frustration with a class, and this frustration appeared to be the result of extraneous factors that they themselves were not aware of, but that would be obvious from the viewpoint of CLT and in the perspective of a cognitive task analyst? This would not mean that the latter theory and the cognitive analyst are wrong. The researcher's point of view, through coding and imaginative variation (Moustakas, 1994), would be to examine the evidence, and validity would be informed by meeting both interpretive goals and providing textual evidence of participants. Researchers evaluate evidence both methodologically and experientially. Rigorous and appropriate procedures yield understandings appropriate to the study; these include Moustakas' (1994) validation through comparing emergent themes to transcript details, and ongoing bracket and reflexive coding of the interviewer's part of the transcript, the focus and control applied to the conversation. The reader also should experience illumination and a sense of plausibility from relating the interpretation and the data of rich and thick descriptions (Pollio, et al., 1997).

Whether or not a researcher may trust that what a novice teacher said was true will be based on perceptions of internal consistency, syntax, diction, and the sense of the learning the reader gets from their account, so that one may trust it is credible (Seidman, 2013). Every aspect of interviewing, the structure, process, and practice had a goal of minimizing the effect of the interviewer and the situation on how teachers shared their experience. The interviewer kept quiet, tried not to interrupt or redirect thinking while it was developing in the teacher, so that thoughts belonged to the teacher, practiced active listening and remained constantly aware of control and focus issues. The researcher's experience and observation offered only limited access to a teacher's experience of classroom CL. The three-interview structure enriched validity by contextualizing the comments, and gave them the space to make sense to themselves and the interviewer, so both understood how they understood. The comparison and compilation of many participants' experiences also enhanced validity (Seidman, 2013).

Ethical Issues

The Belmont Report established the need for ethical research of humans that includes respect for persons, beneficence and justice; the Concordia University–Portland Institutional Review Board (IRB) reviews studies at Concordia University for ethical compliance. This research underwent the process of IRB review before approval.

As part of the submission for review, the Informed Consent Form (see Appendix C) was developed with a view to informing participants of their rights and the risks involved in research. Interviews may develop intimacy between interviewers and participants, and lead to sharing of aspects of life that may cause discomfort and emotional distress during the process; the researcher's misuse of words in reporting may cause embarrassment or harm to a teacher's reputation. Novice teachers have the right to be protected in the way the researcher shares results. Informed consent is a primary step in the minimization of risks to novice teachers who agree to be interviewed (Seidman, 2013).

For the phenomenological interview, Seidman (2013) lists eight parts of a thorough informed consent form, based on federal guidelines for informed consent (Protection of Human Subjects, 2001). They include an invitation to participate that gives information about the study, a list of risks involved, the rights of the participant, the possible benefits, confidentiality of records, dissemination of materials, issues of working with children (and classrooms of children), and contact information (Seidman, 2013). Appendix C thoroughly presents the study, and the responsibilities accepted by the researcher to guard the rights of participants.

This study involved human participants, and the author recognizes the elements and responsibilities of ethical research. Training modules were taken that satisfied human subject research requirements for the National Institutes of Health, which ensured that guidelines and principles for ethical treatment were responsibly met. The University's Institutional Review Board approved the research before data collection and interaction with participants. Subjects of this study will receive and understand the informed consent form and that the research is voluntary, that they can stop at any time without consequence to themselves. Transcripts and audio recordings will be kept confidential and secure, and identifying information was changed during the transcription process. Final compilations of data and phenomenological analysis portions will maintain confidentiality since the research findings may be used in presentations and publications.

Summary

This chapter has emphasized the novice teacher as the source of experience and meaning in the study of teacher CL. The design of this research was phenomenological in that in-depth phenomenological interviews elicited teacher experiences, even as the researcher turned from the natural attitude and theoretical framework of cognitive psychology. The approach to interviewing and then the coding of transcripts and building of themes comprised a phenomenological reduction that moved validly and reliably toward the experience of novice teachers, even as that experience was elaborated and enlarged. The data of stories and experience were explored according to phenomenological principles to give depth to a phenomenon and further demonstrated its relevancy and centrality to teacher learning design.

Chapter 4: Data Analysis and Results

This phenomenological study presents the lived experiences of novice teachers engaged in acquiring greater technical and problem-solving skills in the complex classroom. The study offered an opportunity for teachers to share their lived experiences in the classroom in order to more deeply perceive and understand the phenomena of CL as undergone in classroom environments by teachers hoping to acquire classroom skills and solve recurrent classroom problems. Varieties of these experiences are described to help the reader understand the phenomena of CL from the perspective of classroom teachers new to their careers.

This chapter presents the main themes identified in 18 in-depth interviews of six participants, along with a brief description of the participants. The themes result from the creation of a hermeneutic circle, wherein the researcher brought ideal categories from the CL theoretical framework into a dialogue with the lived experiences of teachers. The taxonomy of CTA and the language of the theoretical framework were utilized to explore novice teacher experiences in depth. Although the questions given to teachers were prepared with the psychological construct in mind, the participants indicated their past training and beliefs regarding learning design were totally outside of the formal construct; expertise transfer with the goal of automating recurrent responses to challenges, isolation of skills for drill outside of the complex environment, and a focus on techniques with specific cognitive steps were foreign concepts and practices. Teachers instead indicated the classroom as the optimum place for learning experience, that time and experience, trial and error based on feedback and reflection, elements of constructivist learning design, were what helped them learn. None of the participants demonstrated familiarity with the theoretical framework, and their descriptions actually expressed a considerable gap between their beliefs and understandings regarding teacher learning and those of CL theorists. Participants were unfamiliar with dual process models of complex learning (i.e., how a working memory interacts with long-term memory), did not immediately identify with the CLT goals of learning (i.e., automating skills, building long-term memory structures), and lacked the taxonomy of techniques and tactics related to CTA models of skill development (i.e., knowledge that expert skills/techniques existed and could be classified, practiced and automated in ways that reduce CL). The study results demonstrate that participants had been immersed in the learning framework of constuctivism and discovery learning, as they declared repeatedly their beliefs that trial and error followed by reflection, time and experience, and the classroom itself were their best teachers. This gap enriched and deepened the study, as teachers described the phenomena themselves surrounding mental effort and their navigation of classroom complexity without the frame of reference provided by cognitive psychology, in their own words. Because of this gap between beliefs about learning / learning framework and actual experience, authentic and rich descriptions were given of the phenomena of CL and its impact on their learning and problem-solving. The major findings of the first three research questions, dealing with (a) the lived experience of CL, (b) awareness of CL, and (c) its consequences to learning, will be presented in this chapter; Chapter Five will present how these teachers' perceptions and experiences provide insight into teacher learning designs, the fourth research question. A summary concludes this chapter.

Description of the Sample

This study included six novice teachers: four females and two males. All of the teachers had gone through university teacher preparation programs, and all had formal co-teaching pre-service training before being hired as teachers and having their own classrooms. Three of these had actively taught in their own classrooms for less than one year, and three for less than two years, and all could distinguish differences in their learning over time in the classroom. Two teachers were elementary grade (K–5) teachers, three taught middle grades (6–8) and one was a secondary school teacher (9–12), but all six presented rich descriptions of CL experienced in learning and problem-solving unique to the skills their grade levels demanded. While different strategies and techniques were being acquired based on grade level as well as prior and current training, all teachers could identify skills and areas of learning. Two teachers were in their second careers and were just over 50 years old, three in their 20s and one in her 30s. Three teachers were parents and described how their experience as parents impacted their CL and informed their teaching practice and learning. Three teachers identified teaching as a first career, and three came to teaching later in life. In spite of their diversity of background, all of the novice teachers in this study considered the classroom as a place of learning and were learning to teach within the classroom.

Research Methodology and Analysis

This phenomenological inquiry explored the capacity for freedom and the inescapable limitations that teachers experience within the real, complex world of the classroom. It began from rich descriptions of prereflective lived experience, accounts novice teachers offered of fluctuations in their mental effort, and moved to a deeper understanding of CL, a psychological construct. The ultimate goal of this analysis is that the reader adopt the perspective the researcher articulates based on the textual evidence and attain a deeper understanding of novice experiences.

The researcher properly arrived at thematic interpretations of lived experiences through identification of invariant structures within the multiple experiences of teachers. These invariant structures have been imposed by biology (i.e., the limited capacity of a human working memory) and by living through the complex classroom environment, and these two elements contributed to shared qualities of individual experiences. The study was not about mental exhaustion or general feelings of stress, but questions focused on how CL was experienced by teachers when directly implementing new practices or solving recurrent classroom problems; questions and answers in the study remained circumscribed within the context of learning in the classroom, and teachers easily maintained the connection between cognitive processes occurring in instances of learning and problem-solving and the experience of mental effort and limits. Novice teachers lived through inner experiences within their environment and described and interpreted their reality in their own words. This study took steps to compare their shared experiences of subjective reality and arrived at deeper understanding and meaning. Every day, experiences such as complex problem-solving and novice teacher learning are given meaning according to the natural attitudes of expert teachers and novices, but the meaning conferred may be naïve or inadequate to the experiences. For example, the experience of cognitive overload in an overly complex set of classroom interactions might seem to be inexplicable, a meaningless mental chaos which overwhelms and must be pushed through, a disturbance in the flow of a teacher's job, or a sign of professional inadequacy. When people confront such chaos in the mind, they may naturally seek to either dismiss it or to reduce it to explanation, to give a meaning to a novice teacher's confrontation with complexity. With questions in this study, novice teacher awareness of mental effort increased even as it was associated by them with specific elements of their learning and recurrent problem-solving. This phenomenological interpretation and analysis revealed the common experiences of novice teachers within a satisfactory and acceptable framework, in dialogue with cognitive psychology, in order to deepen understanding of these experiences for learning designers and novice teachers.

Interpretive Phenomenology Description

Data collection. The six participants gave three interviews each for a total of 18 interviews. Six practical observations facilitated the second interview of each participant and interviewer notes helped participants reconstruct their lived experiences; these observations were clinical in the sense that notations were exclusively of words and actions of teachers and students in the classroom and were not evaluative. The interview questions were designed to prompt novice teacher descriptions of the lived experience of CL. Open questions encouraged descriptions of what it was like to undergo different levels of mental effort during learning, and the types of learning experience based on qualities of the load experienced. While teachers were used to talking about their learning, the focus on mental effort in problem-solving and skill acquisition was unique and brought about a new awareness in novices about their practice. Teachers were also introduced to new language about their practice. For example, they went from a language of "strategies" and categories of teaching to the language of techniques and tactics that isolated specific skills and their actual steps; they heard some practices in class described as "recurrent" or, in a few instances, "nonrecurrent." They also received descriptors of mental effort in performing skills, such as "automatic," "overwhelming," or "overload," and "higher mental effort" or "high CL." The most basic descriptions of CL and the dual process model of thinking were given to novices, how limited working memory interacts with long-term memory to automate skills. Teachers were also coached in the differences between reconstructing prereflective experiences, and reflectively interpreting experiences. Although some ways of thinking of their practice were new to teachers, it helped to direct them to the phenomena of their own experiences, and they very naturally embraced this language and sometimes chose to utilize it in their reconstructions. While for many experts the experience of CL in learning recurrent practices or solving recurrent problems may not be so relevant, for novice teachers mental effort in learning was a minute by minute reality, an ongoing, lived-through fact of their life world. They described singular and unique experiences of "the moment" of teaching and learning, and easily expressed fluctuations of CL. Novice teachers at times adopted the language of the questions, especially in describing mental effort and space in working memory and automaticity, and naturally identified with the concepts and aligned them to their experience. The six novice teachers very easily found their own language for their learning experiences, and some very colorful analogies emerged. While levels of CL were referred to and often utilized by teachers, language used to describe the types of CL (intrinsic, extraneous, and germane) were avoided as these represent CLT constructs and the technical typology of CL that results from CLT learning designs, and teachers were not restricted as they developed their own experience types.

The 18 interviews were audio recorded and then transcribed. The 18 transcripts were then de-identified, with names of teachers being changed to pseudonyms composed with an alphabetical order. The researcher assigned the following pseudonyms to the novice teacher participants: Amanda Betz, Catherine Doe, Ella Finn, Gina Hunt, Ivan Jentz, and Kevin Long. Each interview document was titled with the pseudonym, with the number of the interview (1–3), and the date and time on which the interview took place, corresponding to the audio file of the interview (e.g., "IvanJentz3Sept15, 2017 at 3.54.00 PM"). Within each interview transcript, a minute and second marker divide each block of dialogue and mark the time during which the description took place in the audio recording (e.g., 34:16). The original manuscript of this dissertation condtained the citations of interview material including the pseudonym of the participant, the number of the interview, and the minute and second of the audio recorded block (e.g., *Amanda Betz, 2*, 34:16–35:24); these were removed at reviewer direction from the final dissertation. De-identification of the transcripts also eliminated textual items such as district names, schools, classroom locations and student identifiers, as well as personal information of teachers that would indicate their identities. After de-identifying the transcripts, these were imported into Atlas.ti8 for coding and analysis.

Coding development and theming. The initial reading, analysis and coding was provisional and open to the data. Just as wonder and surprise led discussions with teachers, the reading and interpretation of re-constructed experiences and the meaning teachers gave those experiences were open. The reality explored was more profound and complex than any theory might summarize, and the researcher did experience wonder at the challenges and negotiations teachers described. Open coding involved a close reading without the lens of psychological categories and theoretical themes. For open coding analysis, the researcher asked what the data itself suggested or left unspoken, and how the data indicated new categories, without reference to the construct. *In vivo* coding marked off interesting descriptions and language utilized by teachers about their own learning, the ways they described learning on their feet, about their backgrounds, mental processes and beliefs. Analysis of such experiences proceeded first, without extant theoretical categories in play. From this analysis, a family of codes surrounding teacher beliefs (BELIEF) regarding their own learning design arose and became significant, as well as codes directly related to the specific skill of NOTICING and other taxonomic codes referring to specific skills being learned and developed. While all teachers demonstrated a lack of formal taxonomy, and even voiced a perplexity at the notion that certain tactics they employed had been given names and the usefulness of such a practice of giving names to skills, each teacher had developed their own language of performance and unique descriptions of common experiences, which the researcher identified during the study.

Subsequent reading of the transcripts employed the different types of coding presented in Chapter 3. Structural coding developed several families of code that related directly to the research questions, under which sub-codes and themes were developed. The main family of structural codes, LIVEDEX, addressed the first question of the *lived experience* that novice teachers have of the types and levels of mental effort in complex classroom environments. Sub-codes for this family developed, which included LVL for *levels of CL* and included LVL-AUTO for *automatic level*, LVL-HIGH for *high level*, LVL-LIMCAP *for limited capacity in working memory*, and LVL-OVLO for *cognitive overload*; LIVEDEX also came to include TYPE for *types of CL*, under which were TYPE-EXTRINSIC for *extrinsic CL*, TYPE-GERMANE and TYPE-INTRINSIC, and forms of extrinsic load such as TYPE-EXT-DEFECT for *extrinsic load based on defects in training* and TYPE-EXT-DISTRACTION for *environmental distractions that impacted load and learning*. In the LIVEDEX category, sub-codes were also developed that connected the *taxonomy* or TAXO of CTA and CLT, connecting what teachers described in their own unique descriptions to the theoretical and learning design terms of cognitive psychology; for example, sub-codes such as TAXO-COMPCHALL and TAXO-COMPSKILL described *complex classroom challenges* and the *complex skills* that met these, TAXO-NON-RECUR and TAXO-RECUR identified *recurrent* and *nonrecurrent* complex skills, while TAXO-SIMUL and TAXO-SUPPORTIVE described the kinds of *skills performed simultaneously* with others or *skills that supported* other complex performances. While teachers used different language to describe these phenomena, the taxonomy of cognitive psychology applied to these phenomena in themselves.

A second family of structural coding, AWARE, addressed the second question of how novice teachers become *aware* of their own CL. Subcodes for this family included EXT for *external* and INT for *internal* to describe factors contributing to awareness, with EXT-SPLITATT for *external split-attention*, EXT-STUDENT for external student response, INT-EMOT for *internal emotional*, INT-PHYS for *internal physiological*, and INT-PROCESS for *internal cognitive process or steps*, representing different sources of awareness. The third family of codes, CONSEQUENCES, sought what teachers described as the *consequences* of CL on their own learning and problem-solving. Consequences of CL were labeled according to types and levels of load as well as the areas impacted by CL such as teaching performance, learning design, teacher self-concept, and student learning. Other experiences that related to the theoretical construct but were not directly related to the research questions were also added—for example, EXPERT for *how teachers perceived expertise*, and DEFAULT for moments when teachers made an *automatic or long-term memory choice due to a lack of resources or distraction*. LEARNING DESIGN or LD was included in these families, and terms relating to *learning design* such as TRIAL AND ERROR and CONSTRUCTIVIST-DISCOVERY LEARNING, addressing the last research question, as all teachers commented on their beliefs about learning throughout their descriptions.

The researcher applied other types of codes and coding techniques. Magnitude coding categorized the levels of CL, the levels of skill complexity and recurrence in classroom practice. Simultaneous coding connected types and levels of CL to different types of skills at specific levels of complexity and awareness; for example, LIVEDEX-TAXO-SIMUL (a skill requiring simultaneous performances) often connected with AWARE-EXT-SPLITATT (awareness that the attention of the teacher on the classroom was split between different solutions or responses). Descriptive coding entitled whole sections of stories under categories such as COGNITIVE PROCESS, where teachers described complex accounts of performances, learning, and skills, how their working memory interacted with the environment. Values coding became important with an increase of significance of *teacher beliefs*, coded as BELIEF, regarding their own learning design; sub-codes regarding teacher beliefs were developed in the process of reading that were unforeseen, such as teacher beliefs about GREAT TEACHING, EXPERTISE, LEARNING DESIGN, NOVICE TEACHING and beliefs about TECHNIQUES/STRATEGIES. Taxonomic coding became very important for this research as CL was described within the recurrent challenges and learning of teachers in complex classrooms. Teachers had their own language to describe their performances, techniques, strategies, challenges and problem-solutions. While these descriptions often had corresponding descriptions from the taxonomy of CTA, all of them were unique and informal. It was also noted when teachers lacked a taxonomy or struggled to discover one in order to solve particular problems or reach specific classroom goals. Causation coding identified causes of experiences, especially in the area of awareness and in identifying internal and external sources of awareness, the teachers' engagement with students and with their own emotions and physical sensations.

In later readings and analysis, certain thematic axes emerged and descriptions were condensed, and Axial coding identified invariant structures such as SIMULTANEITY or OVERLOAD, which played a large part in teacher experience. Elaborative coding extended theory of novice teacher CL, as NOTICING took a more prominent role as a continuous item within teacher working memory, and as teacher attempts to communicate their complex experiences and the forms of communication became problematic. As the novice teacher experience of CL took on dimensions unique to their learning, themes were elaborated regarding their learning design.

Because of the emergent themes, the analytical reading focused on the research questions, and not on the development of unique novice teacher profiles. Phenomenological studies often present each participant's descriptions as a profile, which emphasizes the personal narrative of each participant. Seidman (2013) offered profiling as a way of presenting interview data, describing the participant in context or seeing the participant in a process and personal story, one with dramatic discoveries and fulfillments. Although this research did not formally develop profiles and was organized thematically, elements of teacher history and background (first interview) gave information about levels of training and the teachers' beliefs, understandings, and theoretical frameworks for their own learning. A powerful gap emerged between teacher beliefs and understandings about their learning design and the actual experiences of mental workload and how these truly relate to novice teacher learning. The second interviews reconstructed teacher experiences of rich cognitive processes reflecting types and levels of mental effort as well as how teachers became aware of load. The third interviews explored the meaning of CL and how it impacted teacher learning and teacher self-concept. The Seidman Interview Structure fulfilled its purpose in that it gave depth, richness and context to the descriptions given, but the focus of the analysis remained on the research questions. Seidman (2013) considered thematic analysis as more conventional, and the formal development of this research follows a thematic approach. Although each participant had a profile with a powerful story of their learning to teach and with both resolved and unfulfilled stories of their struggles to learn in a complex environment, the focus of this research was the lived experience of CL, awareness of the phenomenon and the perceived consequences of mental limitations and automaticity on learning and learning design.

Openness characterized the interpretation of novice teacher accounts, and the researcher gave descriptions equal weight as horizons of the experience. The researcher repeatedly read and analyzed teacher accounts and quotations and descriptions were coded and categorized during each reading. This phenomenological study moved from first person descriptions of CL experiences to descriptions of the phenomenon of CL at a more general, invariant and essential level. An example of this movement is found in Husserl's *Logical Investigations* (2001), where he describes the conscious experience of naming his inkpot; after describing this act, which he performed on a specific object on his desk, he moved on to describe the phenomenon of naming things in general as a conscious act towards something. Each section of this analysis demonstrates this movement from particular, unique instances to the thematic, from prereflective descriptions of cognitive processes to condensed composite descriptions. Each teacher described their "inkpot," and the researcher was open to their experience and allowed textural and structural themes to emerge, and memos and notes were written regarding descriptions. The researcher compared and condensed textural themes, the *what* of teacher experience. Applying imaginative variation to these themes, for example, asking what these textural themes meant in the context of stated teacher beliefs regarding learning design, produced structural themes for the study.

Summary of the Findings

Teacher Mental Workload as Awareness of Learning

No one involved in teacher support doubts that new teachers experience mental effort in their initial years as they solve problems and acquire new skills. However, this lived experience, while perhaps relevant to some elements of evaluation, for example, creating emotional sympathy or concern for teachers undergoing it, is simply not treated as relevant to current learning design and is not immediately utilized in evaluation of particular skill levels. However, when novice teachers in this research focused attention and awareness on their levels of mental workload, what they experienced in the moments of classroom teaching, this also made them aware of their learning levels. Lived experiences explored *the moment of CL* in the classroom, that mental effort intended something, an object, invariably a mental resource or performance, and teachers became aware of qualities and characteristics of mental resources and performances that had to be brought forth in that moment, in the classroom. This could have been predicted by phenomenology, wherein conscious intention is always toward something, but the greatest finding of this research was the multiple directions and levels of awareness brought by the experience of bringing learned performances and problem solutions forth in the mind, in the classroom and forth in the moment. Awareness of CL, as expressed by teachers, was awareness of real learning and deficiencies of learning as such awareness occurs "in the moment." Teachers became aware of the strength of performances and problem solutions, their immediacy and availability, by turning inward, to the place where learning really happens, and reconstructing the dynamic struggles to enact performances in the life-world of the classroom. They became aware of their real learning.

Teachers described awareness of what the researcher came to call "real learning" during analysis. Real learning was not merely information studied or given programmatically, a static recipe for classroom practice to which novices had been exposed; novices remained somewhat cynical regarding such programmatic learning. It was not programmatic. It did not exist in the mind as a block of information, a knowledge base accessed by pushing a button. Real learning appears along a spectrum and was discovered in the moment of mental effort as bound with singular and unique cognitive processes within the complex classroom. While expert teachers may not be used to evaluating specific acts of teaching based on mental effort associated with these, novices naturally did so, identifying what had been really and satisfactorily learned based on levels of automaticity and mental effort, whether an act could be performed simultaneously and supportively with other complex processes demanded by the classroom. Real learning, in the life-world of the novice teacher was known "in the moment" as performances and problem solutions that were immediate and available or were not, that were clear, proven and effective, or were not. Real learning was always situated in memory as a spectrum of strength and weakness, responsiveness and frustration, immediacy and availability of cognitive resources, of "instant knowing and doing" or "drawing a blank" or a process somewhere in-between. It is hard to judge how aware novice teachers were of their "real learning" before they explored and described mental effort experiences in interviews; what must be said, however, is that interviews made novice teachers attend to and reconstruct mental effort "in the moment," and this brought about multiple and singular directions of awareness that shared common characteristics. Novice teachers became aware of real learning and powerfully and naturally evaluated their skill levels in the moment.

Novice teachers taught in "the moment." Teachers constantly and clearly affirmed that classroom interaction happened in the moment. The moment came and went, was full of challenges or simple pivots, of decision and execution of recurrent techniques and pivots, critical or simple changes in direction, and was the moment of real learning meeting a real challenge. Novices experienced success or failure in the moment, decisive changes or lost opportunity, and each success or failure had its unique texture. When mental effort was attended to in reconstructions, when *this* moment was seen as *this* mental effort in *this* moment, powerful directions of awareness were revealed. They became aware of their urgency or ease as "the moment" came and went: *this* moment of noticing real classroom demands, *this* moment of searching for a performance, *this* moment of enacting this performance for *this* student or *these* students, and being aware of *this* response or *this* level of efficiency. Teachers exposed the simultaneous demands classrooms make on their cognitive processes, and the difficulties they were attempting to overcome with practice, with attaining real learning. From each singular and unique anecdote, awareness of CL became awareness of real learning. Moreover, interviews about CL "in the moment" of enacting new performances and problem-solving transformed the conversation about teacher learning.

While novices received constant feedback about their performance from other teachers, professional coaches, and administrators, they affirmed that conversations about mental effort were absent. They were not used to an intentional focus on mental effort as it connects directly with discreet acts of teacher learning, problem-solving and related cognitive processes, or treating it as a phenomenon of learning. The phenomenon, however, was pervasive; there was no point of novice teacher experience where they were not searching for performances or mental resources, where they were not attempting to engage with students, at varying degrees of mental effort. What may be the most relevant and potentially informative experience of novice teachers had been ignored, the tell-tale reality that revealed the strength or weakness of real learning.

While CL was pervasive for novices, deep awareness of mental workload and mental space was new, but led to powerful description; the most common element of teaching experience apparently does not require much real awareness in order to be there. Participants were not only able to easily identify fluctuationas in mental effort, from automaticity to overload, but easily formed new awareness of their real learning from this. There was a massive gap discovered, through these interviews, between the researcher's own awareness of CL and novice teacher awareness, and this was a source of powerful findings. Professional educators approaching this research, reading these anecdotes, may need to overcome expert bias; experts, by definition, are no longer aware of CL in their recurrent practices, and this is a blind spot, as several novices described of the experts they work with, and as the literature review demonstrated. Outside of cognitive psychology, this is a new way of listening to and experiencing teacher learning. This research offers an opportunity of understanding and awareness. It requires the reader to allow *mental effort in the moment* into teacher practice, and follow the new awareness that resulted, to see the structure of conscious intention, of mental effort as it connected to teacher learnings, which are the heart of practice and teacher learning design. If the expert reads each novice anecdote and says: "I do not think this way, and have never thought this way, and I am an expert teacher, so this cannot be relevant to teacher learning," then the path may not be followed. If the expert realizes, "I once experienced this, went through this, but I forgot it as I became an expert. This is something I should look at again," then a shared awareness and powerful conclusions about learning design may follow. The most powerful finding, demonstrated in every account to be given, was how easily and naturally novice teachers themselves explored their life-experience through this lens, and themselves made powerful connections to their own learning through it.

The researcher had simply shifted the focus of conversations about learning to mental workload and cognitive processes. The researcher introduced certain ideas: the idea that working memory has limits that can be explored and the suggestion that learning builds skills in long-term memory. This change in conversation about teacher practice had a dramatic impact on participants. Mental workload was a known factor for novices, who constantly underwent cognitive processes impacted by limited mental capacity in the moments of decision, performance, and problem-solving. They accepted this change of conversation instantly and seemed often to leap into answers to questions, pulling apart complex experiences. While at times they struggled with *discourse,* how to *express* the complexity of cognitive processes, which will be explored as a theme, they embraced the struggle and found ways to navigate it. It was not a struggle to find CL, it was a struggle to talk about something they had never talked about. It was not a struggle to connect CL with real learning, for all had singular and unique moments where both were given, at once, but novices did struggle to contextualize these moments, to situate them in their overall practice. They had all experienced levels and types of mental workload in each attempt to solve a problem or acquire a skill, and each had experienced limits in unique, dynamic, and ongoing, minute-by-minute revelations, and all had experienced dramatic examples of automaticity in themselves and in those experts they strove to imitate. All experienced the daily struggle to push back mental limits in the classroom, and the struggle that goes with reaching for a skill or to grasp each step of a complex process. In other words, the phenomenon CL and the phenomena surrounding levels and types of mental workload were very, very familiar to teachers, pervasive realities of their mental world and lived experience. They had simply never chatted about them, never turned their attention inward in a conversation about their own cognitive processes.

The 18 CL interviews truly served as a gateway to wonder at the complex life-world and inner world of teachers as they learned to teach. The researcher, who has spent years giving advice to novice teachers after listening to experts, utilized a vehicle and framework for listening to novices in depth about the most profound element in their learning. Phenomenological wonder, with new ways of listening openly and opening experience, is a powerful tool for the daily practice of teacher learning designers. Novice teachers became more aware of their learning in a new paradigm, accessing a language describing mental limits and the reduction and elimination of limits, shared stories of their expert-like triumphs and their most crushing moments, all the while exposing their hopes for themselves as teachers and moments of disillusionment. The researcher came into the study having strong beliefs about the science and art of learning to teach. He completed these phenomenological interviews with new beliefs about the science and art of listening to novice teachers. Novice teachers all have powerful and relevant information to convey to their coaches about the best learning designs for teachers who are learning on their feet, especially when their most pervasive and continuous experience is the focus of conversations. The researcher was convinced of a better science of listening, and the dynamics and benefits of the CL Interview will be discussed in Chapter 5.

The Essence of Cognitive Load and Awareness of Real Learning in Novice Teacher Learning

Mental effort for teachers was, specifically, the struggle or ease of grasping, in the moment, for immediate and available cognitive resources and performance steps from memory within the complexity (simultaneity) of classroom environments and concurrent mental performances.

The six teachers interviewed simply focused on reconstructing their mental workload and its sources, but their environmental and mental demands unfolded a unique life-world, described in their own words. The complexity of the environment specific to teaching is a known fact, but it must be understood as a complexity of simultaneity. What teachers experienced were simultaneous demands on their mental processes and their unique cognitive demands, always present, to solve complex problems and perform complex performances also simultaneously. A teacher lecturing was never just lecturing but was always performing other skills at the same time; a teacher redirecting students was never only performing this one task of management, but working memory always was challenged with multiple tasks, simultaneously. Teachers were never only doing just one task because the classroom never demanded just one task. In terms of the unique complexity associated with influencing more than two dozen minds at once, continuously, through multiple tasks, goals and distractions, no other profession presents the qualities that a classroom presents, and teachers described explicitly “the moments” wherein consequent levels and types of simultaneity unique to teaching were required. More importantly, through descriptions of mental effort in this environment, they revealed experiences of how specific types and levels of learning met these demands in a wide tapestry of descriptions. The primary invariant constituent was the mental limits of working memory (biological limit) either learning to thrive or failing as such memory was challenged repeatedly and persistently to access multiple resources and performances “all at once” or “in the moment”, and the complex simultaneity of 25–30 children needing multiple responses, to be taught and managed, moved and motivated “all at once” or “at the same time” (environmental complexity). This mental and classroom space was where learning and problem-solving happened, as teachers richly described.

Simultaneity of skills and simultaneity of separate mental processes are the untaught but very real goal of novice teacher complex classroom learning. The triumph of automaticity of skills, as described by teachers, was that reduction of mental effort alone allowed them to meet their goals, and teachers were very much aware of this happening. Mental effort was less the result of individual cognitive processes and their steps, and almost entirely resulted from the barrage of multiple tasks, a constant simultaneity of different goals presenting in the classroom. Even as teachers practiced the steps of one process to meet one goal, they were also, at the same time, reaching for the next skill and process for a separate issue. This latter activity of mentally reaching, searching for each step, grasping for the tool or technique or script that would resolve the next issue, even as other process were also receiving attention, was the very essence of participant mental effort. Teachers explored and discovered the borders of their working memory limits when distractions carried them from immediate goals, when defects in learning and skills created a constant mental reaching and searching, and when they met problems by defaulting to natural reactions. Steps of unautomated individual processes became heavier and demanded more focus in this complex simultaneity, sometimes to overwhelming points. Mental effort for teachers was, specifically, the search (grasping), in the moment, for immediate and available cognitive resources and performance steps from working or long-term memory in response to the complexity (simultaneity) of classroom environments and concurrent mental performances.

The simultaneity of classroom complexity was perpetual. While the goal of CTA and CLT is automation of skills, the building of long-term memory schemas, the goal of classroom teacher learners was simultaneity, and automaticity only helped to meet this goal, and was perceived as a means to this goal. This was unique to teaching, in the researcher's view. Teachers hardly noticed the victory of an automated task, but not only because this occurred when a process was made automatic and, hence, an individual problem could be solved without noticeable effort. Rather, they hardly noticed automation because the next resource and performance to enact and learn was always there. While teachers were aware of automaticity, the problem of simultaneity remained and remains for all teachers, both the novices searching for recurrent techniques and, one may predict, experts searching for nonrecurrent strategies, with the next issues continuing to apply pressure toward the next goal, the next search for resources.

The Gap Between Complex Cognitive Processes and Communication Processes

Descriptions of this mental effort (grasping for cognitive resources) revealed a gap between the actual phenomena experienced and the communication of such phenomena. While teachers very naturally identified with the construct CL, they also found new ways to communicate what they were living through in the classroom; the problem of discourse about complexity and CL emerged. The study of CL was ideal for a phenomenology in that this science is about exploring and communicating in depth the most obvious and pervasive realities, even as it may be critical of words about those realities. The power of phenomenology is that it arrives at phenomena, no matter how complex. Teachers were not merely co-researchers, but co-phenomenologists, in that they explored and then found ways to overcome the communication gap between lived experiences, in the moment, of complex cognitive processes and discourse about these processes; teachers were always overcoming this gap in communicating, and found effective ways to do so. Their effort to communicate and the ways they discovered to communicate were a powerful finding in this study. Teachers are communicators and embraced this challenge during interviews to describe the complexity inherent in their learning experiences. First, they utilized analogies for the complex simultaneity they experienced environmentally and in working memory. Second, they layered separate mental events in a manner representative of cognitive processes occurring simultaneously. The researcher did not reject these as post-reflective analysis but accepted the layers as occurring at once, just as they were given by teachers in reconstructions. The researcher judged that actual teacher experiences had a magnitude beyond conventions and narrative streams of language, and overcame the prejudice toward a more discursive form of thought. An important finding that emerges from the struggle in many teacher accounts: when one listens to teachers describe their mental workload, one must understand limitations in discourse to overcome this gap with the teachers.

The Gap Between Teacher Beliefs About Their own Learning, and Teacher Meanings Resulting From Their Experiences of Cognitive Load.

Teacher beliefs about their own learning powerfully impact that learning. The researcher found a gap between novice teacher beliefs about teacher learning and their actual experiences during problem-solving and acquisition of new skills. Beliefs about “trial and error,” “time in class and experience” and that “the classroom was the best teacher” conflicted with the awareness given by reconstructions of CL experiences. Teachers gave indications that these beliefs had been formed by both the programs that supported them and constructivist learning theories. Programs of support had provided information about teaching (as opposed to drilling techniques to automaticity, to immediate availability in memory) and had encouraged study and practice of nonrecurrent teaching skills (as opposed to the recurrent practices that daily occupy teacher working memory). Teachers expressed a number of beliefs supported by a constructivist learning framework, which holds that adults build meaning through interactions with an environment and that reflective work on such interactive experiences is the best model learning; knowledge is created within, not from without (e.g., handed to novices by experts). Teachers repeatedly stated convictions that the creative process of "trial and error" would make them experts (as opposed to transfer of researched practices), that "time and experience" in the classroom would change them (not drill of tactics to automaticity), and that the classroom environment was their best teacher (as opposed to expertise transfer). Several teachers were perplexed when asked about their "techniques" or tactics for solving problems; the suggestion that techniques existed for each recurrent classroom problem or goal was equally foreign, as was the concept of drilling techniques to automate these in working memory. Teachers believed that trial and error with time and experience in class had built their practice. Learning was more a creative process, and less a transfer of expert, proven practices.

The essence of mental effort for teachers was, specifically, the struggle or ease of grasping, in the moment, for immediate and available cognitive resources and performance steps from memory within the complexity (simultaneity) of classroom environments and concurrent mental performances. New understandings of learning emerged when teachers explored the reality of their pervasive mental effort, and new goals and understandings of their learning also emerged. What was actually helpful to teachers was revealed from stories of cognitive overload and automaticity, accounts of how higher levels of load both helped and hindered learning, and teacher descriptions of extraneous distractions, defects, and defaults to immediate, albeit ineffective practices. These stories did not simply confirm CLT; teachers did not have CLT explained to them. Teachers simply used "mental effort" to evaluate their own learning levels, and did so through a natural story-telling process. Exploring lived-through experiences of the limitations of working memory as they practiced and acquired important skills had the power to shift teacher understandings, and they expressed these in their own words.

Novice teachers gave powerful descriptions of cognitive phenomena, real events in their mental processes during learning, and these actual happenings cannot be discounted by any theoretical learning framework. The power of phenomenology is that it studies real phenomena. Teachers explored where their learning actually happens, in their cognitive processes, and were able to measure and evaluate their progress with a different measure, assessing the availability of mental resources and steps of performances and their immediacy. They identified the classroom as a deficient and distracting learning environment, as a place where acquisition of skills was at times impossible. They also identified deficiencies of learning, missing steps or missing processes, performances that could not be repeated or done for lack of memory. The researcher experienced participants adjusting their views of skill level in the moment, based on the lens of mental effort. Just as CLT researchers evaluate learning design through levels and types of CL, teachers naturally did the same in their own language. Although teachers were resilient in maintaining powerful beliefs about their current learning design, beliefs ingrained in them through the types of support they were receiving, their lived experience indicated to the researcher new trajectories and goals for learning design which could be met through expertise transfer.

Presentation of the Data and Results

The First Research Question

The first research question asked, what is the experience that novice teachers have of different types and levels of mental effort in complex classroom environments? The analysis begins with the specific complexity of the environments teachers experienced and lived-through and richly described. The first emergent theme, simultaneity, was an invariant constituent in teacher lived experiences of the complexity of the classroom environment. The fact of simultaneity and its impact on mental effort levels and types was specifically described with reference to the skill of noticing. Textural analysis explored the ways teachers communicated simultaneity, the reasons behind their communication as a problem of overcoming the limitations of discourse. The teacher experience of automaticity, overload, and high CL follow, and serve as textural descriptions of how teachers experienced fluctuations in CL during learning and problem-solving. The types of CL, intrinsic, extraneous and germane, do not have their own section, since teachers were allowed to bring their own qualitative descriptions of how they experienced load, but these types are referenced in structural analysis of levels. Structural analysis of each level explored the types of CL, germane, extraneous and intrinsic, but focused on how these emerged on their own in textural descriptions, along with issues of taxonomy and the ways teachers experienced their own learning. The descriptions which follow focus on the first research question, and do not treat the questions of awareness or consequences, which have their own individual sections; however, awareness and consequences are powerful factors in the shared descriptions regarding levels of load in classroom complexity. The sources of load as experienced, how classroom events and cognitive processes interact to produce mental effort, are the immediate focus.

Simultaneity. Simultaneity refers to a performance or process occurring, operating or being done at the same time. As participants reconstructed experiences of mental effort, the unique complexity of classroom teaching emerged: learning and problem-solving happened in an environment demanding concurrent performances, which teacher thinking either met or was distracted by, depending on how teachers learned and problem-solved. The mental effort of teachers fluctuated or was overcome as they sought to navigate and develop their own simultaneity.

***Textural synthesis*.** In describing her lived experience of circulating, Amanda Betz immediately reconstructed several simultaneous processes of tracking students and lesson delivery. Her mental effort did not intend one object. Prior to this interview, the researcher had observed her circulating (described by her as using “proximity”), her tracking and her lesson delivery, and was trying to elicit a description of the complexity of steps in this individual skill, but the teacher went deeper, rapidly describing what was not observable, that is, her mental process:

> Betz: If they remain the same level of engagement, or if it dipped, or if it spiked—because I know [with] proximity, when I get close to the ones who are talking most of the time they stop talking. But does that mean that they’e really more engaged, or does it just mean that they stopped talking? And that’s what’s going through my head. Did I just break up a side conversation that was really about this, and I should have drawn attention to it and have them share? Or were they really off task and I helped. But now, uh-oh, I’m not in the front of the room, and I need to go click my next side so we don’t get behind schedule.
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> Interviewer: All this went through your head?
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> Betz: Yes.
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> Interviewer: Today? [during the same-day observation]
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> Betz: Yes. Just in that one swoop through. I just don’t know—
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> Interviewer: Is it because I was observing you or—?
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> Betz: No, I don’t think so. I think that goes through my head every time I circulate, because I circulate a lot during work time, all the time. I never come sit at my desk. I’m moving around the whole time.

Her entire account was “a moment” of teaching. Her mental process included a checklist of different mental items and goals, separate information she was actively seeking, even as she moved through the class and delivered her lecture. Her effort in circulating had multiple objects and awareness directions with goals in mind. When the researcher expressed some amazement at

“All this went through. . . ?” she offered a simple affirmation. In one quick “swoop” her mind, she declared, had done many things. She finished by describing this inventory of thinking and acting as her repeated practice, as “that [set of questions] goes through my head every time.” Later, in subjectively reporting on her level of mental effort while circulating, attaching a number on a scale of 1 to 10, Betz offered a different reconstruction. In it, awareness of simultaneity of demands and thinking helped her arrive at the measure of effort within her mental process and in her processing.

> Interviewer: What would [your] circulating today have been?
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> Betz: It’s like a four or five. I don’t think I’d go higher than a five, but it definitely just pulls me out of— if I have a thought of, “Oh this is good. I’m going to bring this up, or I’m going to touch back on what this student said earlier,” I feel like I can’t do that when I’m circulating because I’m thinking about who I need to go stand by [and] if they’re quiet, and continue talking, and staying on task, but also looking to see if their cell phones are in their lap. So I feel like there’s more things going through my brain, but I don’t think I’d go higher than a five because I still feel like I’m on task, and I’m talking, and can monitor everyone else, and answer questions as they come up. But I wouldn’t go lower probably than a five.

She was moving around one technique from many angles here, and evaluated that technique according to mental effort. The turn to her cognitive process brought about a description of “more things going through my brain,” and a list of activities simultaneous to the one particular mental effort she was measuring, circulating. She gave her CL measure in the scale a five, in spite of “more things” going through her brain. To get this “five” for circulating, she referred to the list of other activities she simultaneously did as she actively tracked students: she was thinking about her lecture (“Oh, this is good. I’m going to bring this up.”) and a new direction that she would take it, while she also tracked students being on task, looking for multiple signs of disengagement. She brought in these other tasks to measure the one, and seemed to consider it mid-level due to the others. In this scenario, there seemed to be distractions, but these were not a concern to her in that she felt she was “still . . . on task” (lecturing, eliciting student knowledge) and could talk and monitor and answer questions, all at once. The simultaneity of the inner activity and outer problems to monitor and resolve was simply a given in her description. A researcher question that aimed a teacher at subjective reporting of effort in a particular skill brought the teacher to shift focus to others concurrently happening. This shift in reference to other skills happened in almost every novice teacher description of their mental effort when one skill was asked about, a shift to actual learning and environmental demands. Mental effort was never simple, but occurred in unique and singular circumstances of cognitive ability and classroom demands. While it might seem this complexity of tasks would be a hindrance, Betz said that it was actually something that “is teaching” and indicated that it was something this teacher would never cease to “want”:

> Well, that is teaching. I don’t think I ever—I don’t ever do want just one thing. You’re always scanning the room. You’re always checking formatively. You’re walking around. You’re testing the waters to see what they’re thinking. You’re also teaching your content at the same time. You’re thinking ahead. like, “Okay. This next slide, be ready for groans because it looks complicated because there’s a square root sign.” I don’t think you’re ever just doing one thing at once. . . . It’s just whether you feel comfortable and competent when you’re multitasking.”

“I don’t ever do want just one thing” was a profound and resolute statement about her learning. Teachers’ mental effort was, here and elsewhere, the intending of performances and skills, but also their immediacy and availability. It is a learning want, a learning-to-teach desire. She made it because there were “always” the multiple demands. “Multitasking” here, in this context, was not the traditional use; it did not describe a busy job, but a pervasive and shifting set of mental demands. The inventory of what one is “always” doing remained, and, according to her, remained active. This was teaching. This teacher would not ever *want one thing*, not *ever*, but desired to do the multiple things together. Finally, working toward this, learning this, was a *competency* of teaching, an ability with which one must become *comfortable*. There were “always” certain performances which were being done “at the same time” and she questioned if there would ever be a performance of “one thing at once.”

Most of the descriptions within this analysis of complexity of the classroom or complexity of performances involved the desire, the want for comfort and competency in meeting a simultaneity of classroom events and concurrent cognitive processes, and this part of this section will only examine a few exemplars. Interview questions about mental effort, accompanied by general questions about complexity of the classroom, distractions, and the recurrent skills teachers were seeking to acquire, provoked descriptions of levels of comfort and competency within simultaneity. “How complex does it get?” and “What was that like?” were the questions that produced this result, which was not a question theme.

During analysis, the researcher wondered if simultaneous thought processes moved concurrently or whether such thoughts moved consecutively at great speeds. Novice teachers, in dealing with concurrent problems in the classroom, did describe a process of quickly prioritizing. When Kevin Long was asked how complex his thinking had to get, he described:

> I don't know. I mean, I don't know if any of this is really complex by itself. If I could address one conflict by itself, I don't think it really is complex. But it comes when there's so many things to deal with, then I can't—I basically have to choose which one I want to deal with. So yeah, I mean, I don't think any one of them are very hard to deal with. But when you have so many, that's what makes it complicated, is how am I going to address all these different things at once or within that class period. . . ? I don't know. I'm kind of getting away from that complexity question.

The last phrase is telling in that he thought he had gotten away from the complexity question, but instead had described the effort necessary "when there's so many things to deal with." His perception was of two different issues. "If," he said, he could address one conflict by itself, that would be simpler, not really complex. But complexity "comes," and he described it as when "so many" things, "all these different things" have to be dealt with "at once." His assessment, "I can't—" remained unfinished, a teacher had it mentally in front of him again and was unable to move forward, but then he focused on the solution of choosing between items, none of which, taken alone, were difficult. He saw the complexity, and then saw himself navigating it. The complexity was in the amount of performances, not the individual performances, and the acts of choosing what to respond to. He believed he needed the skill of choosing which response would have a singular focus, to take the complexity apart. Amanda Betz described similar demands:

> So many things can happen in just 30 seconds. It doesn't seem like that long, but this kid can have a blowup and this girl can be being snotty about someone and that guy left for the bathroom, and he's been gone for 20 minutes, and I don't know where he is. Oh, yeah. And then my Admin came in to evaluate me at the same time. I don't know.

> There's lots of things going on that you have to split your attention between [while maintaining] 100% effort. You can't just half—you know what?—the job and expect it to get done. . . there's so many things that require your attention at the same time that sometimes it's hard [to decide] which one to do first. And I feel like that's what I do in my head. "Okay. What is instant right now? I need to take care of this—and what can be on the back burner for another minute?" So, I'm constantly analyzing number one, two, three, four, five, what I need to do first.

What happened in the head had to do with the moment, those seconds in class where something had to be "instant right now," and that demand was not solitary. There was a level of urgency indicated here, that there were so many things happening and what must be "instant right now" needed a decision. Immediacy in the performance was the intentionality of mental effort. Amanda offered an example of the language of simultaneity, of split-attention between lecturing, moving, tracking her class and directing students to engagement. She also gave what will be seen throughout the descriptions of mental effort to follow as the object of mental exertion, responses she was reaching for in her mental process: "What is instant right now?" Among the "so many things" that were immediate happenings there was that which had to come immediately. Her mental effort was in both finding that something and in prioritizing it with all the other elements of the moment.

While the researcher saw her performing multiple tasks at once, as an observer, the invisible mental process was hidden. Did it involve mental processes performed at great speed, as in quick, consecutive decisions, or were the mental steps to different tasks happening concurrently, at the same time? Both descriptions were present. Multiple things were being done "at once" and “at the same time,” but also described as having to be prioritized and sorted quickly for performance. She also described meeting the demand for simultaneity as a mental process and learning process:

> Okay. I feel it is complex, but it’s a bunch of little simple things that make it complex. So if I can just learn how to break it down quickly in my head, I don’t think it’ll seem as overwhelming or complex for me. I mean, technically, it’s complex because all these multiple things are happening in the one short time span. But if I know this kid’s probably going to ask this question, and this kid, he looks like he needs to take a lap, or that girl over there, I know her home situation, and she’s going to need extra one-on-one help, so I need to go tell her, “Hey, just get through the lecture, and I’ll help you one-on-one later.” I think as time goes on, I’ll get better at knowing what to do and quickly and efficiently doing it. And so, yes, it’s technically complex, but if you kind of break it down in[to] all these simple little things, it won’t be as bad.

This mental activity of “break[ing] it down” was the heart of the description. But what was “it?” She described, first, the demands for her learning, what the learning was as “technically complex.” The texture of her description was characterized by multiple additions of thoughts about this student or that student, tracking the different students before her, the teacher slipping into and articulating the multiple happenings as questions and responses to problems she was noticing, but all happened in “one short time span.” During reconstruction, teachers often slipped into such quick mental inventories of the moment, like they held a large onion and then quickly peeled back the layers of a single classroom transition. Second, she asserted a process of dealing with the complexity of multiple items, “break[ing] it down quickly” into “these simple little things.” Based on the demands, this seemed a powerful mental act of arrangement. Her learning goal would be achieved “as time goes on.” With the passage of time, she believed, “I will get better at knowing what to do” followed by performances that were quick and efficient. “In time” the resource would be there, the knowledge, and the performance would follow. She described this knowledge not merely as good information in memory, or having a knowledge base. What characterized her desired learning result was a series the events of knowing and performing, and the quickness and immediacy of response, and efficiency or the lack of wasted energy that produced the desired result, as well as her ability to comfortably and competently complete performances. Possibly, she saw all of it as one great mass, but, as time went on, she would “get better,” or learn the skill she needed to “break it down quickly” in a thought process that prioritized. In every interview, teachers described the demands of the classroom and their learning in terms of such multiple happenings occurring simultaneously and indicated that over “time” they would “get better at knowing what to do” and do it quickly. Betz and Long expressed it as breaking complex simultaneity into simpler chunks. This prioritizing and arranging, performed constantly over time, was thought to become faster as it became a habit, such that it could happen even as other things were being processed in working memory.

Teachers described mental simultaneity both as events of faster consecutive processes and also as concurrent mental processes. In reconstructing her experience, Amanda Betz described how the complex environment pushed her mental process into dual tasks as she was helping an individual student and also “scanning” or tracking the rest of the class:

> I think I’m instantly—my attention, just like it would be for any of the other kids, gets pulled to wherever that noise is. And I still want to be respectful to whoever I’m speaking with. And I feel like I can listen to what they’re saying. And I just briefly glance at their paper and can usually see where they’re going wrong. So, I can put more attention on

> scanning the room and figuring out where it's happening. So, I can be like, "Hey, let's focus on our own stuff right now," or whatever, and then still come back to what I'm working on with the student. But I feel like I have to do that a lot with my bigger classes. I know I'm not as good at it, and I don't think I do that automatically in my other classes because they're so small and well behaved. But I know that I should still do it because scanning still lets me know if someone's raising their hand, who needs help. But with that class particularly, I can never have my sole attention on one student ever. I constantly have to be watching out for girls being catty, or these guys trying to skip, or this person just spilled their drink, or—it's just a chaotic class.

This participant was describing shifts of mental effort, of attention being needed here and there, and her own level of doing things "automatically" based on changes in the environment. She described her split attention as she performed one cognitive process while her mind was also "pulled to" other events and goals in the classroom. The larger the classroom, the bigger the pull of what she called "scanning" or tracking. As she was both scanning and leaning over the individual student however, she felt she "can listen to what they're saying." Her mind could be divided. Interestingly, she described herself becoming less "automatic" in her better-behaved classes. She seemed to feel her processes had to be more automatic in the more difficult class. The more "chaotic" the class, the more need for split attention and automaticity, as she never gave her "sole attention" to the student she was helping, but had to keep an eye on everyone, "constantly," all at the same time. The "automatic" was described as less necessary for the smaller classroom. While she described the simultaneous environmental demands, she naturally attached her mental processes, resources and performances, mirroring the simultaneity mentally.

More automatic performances were often described, as Betz did, in association with the need for simultaneity. Teachers who navigated this unique complexity while reconstructing their levels of load identified the need to automate skills. Several teachers independently described simultaneity with analogies which will be explored throughout this analysis, such as “juggling,” or moving multiple balls through the air. When Ella Finn was asked how she would know when she arrived at expertise, she gave this description of her teaching:

> Finn: I feel. . . I’ll be able to be that person that juggles 50 things at once and you can tell I’m juggling.
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> Interviewer: Okay. Will you be able to tell you’re juggling, even, do you think, or—?
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> Finn: I think I won’t feel like I’m juggling. I think it will feel like second nature. It will feel like it’s something I do all the time. It will feel like [laughter]—
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> Interviewer: Yeah. I love that image of you, hop in the front of the class with all the balls in the air—
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> Finn: Yeah. And I don’t juggle. But—
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> Interviewer: —and you’re just explaining the lesson very calmly [laughter].
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> Finn: Exactly. Exactly. . . . And I cannot juggle for the life of me. I cannot juggle. But that’s what it is [laughter]. It’s juggling.

Finn was familiar with real jugglers. Her image of the juggler evoked a hoped-for ability, “I’ll be able to be. . . .” Jugglers make multiple things move all at once, continuously, almost automatically, and do not drop or lose any one of the objects in hand. In her description, automaticity, doing several things unconsciously and feeling it is like “second nature,” is again linked to simultaneity. Ivan Jentz reconstructed a very difficult classroom situation, then also spoke of “juggling” in his current practice. His classroom was chaotic during observation, and multiple problems manifested at once throughout. Like Ivan, teachers during interviews pictured the class they were reconstructing, and the researcher could tell they were often mentally reliving moments, re-engaging themselves in memory. The interviewer asked Ivan, "Tell me about juggling."

> You just react. I mean, I don't know that there's a method to—for me, at least, first-year teacher, it's just trying to do my best to deal with—how do I say this? You just look at what is contributing the most to this thing going off the rails. And you just try to get it back, cut that out. And then, you try to figure out what's next. . . . And then at the same time, deal with the kids who have questions or the kids that want to know if they [can] go to the bathroom.

Again, he prioritized, from awareness of what createed the greatest problem. Simultaneous demands produced the analogy here, "And then at the same time," but not the mental concurrency. His was a struggle for language, "how do I say this?" to describe this elusive complexity. This was a memory of "the moment" as well, and evoked those seconds or that minute in which thinking had to be immediate. All of the wild elements of his observed class, that cannot be recounted here, were blended together in this vague description of "what" and "this thing" and of getting "it" back that represented his lesson, but he was talking about as many as twenty students each going in all directions at points. One of the researcher's memorandums said: "Jentz juggled with knives and chainsaws." But he still wanted to juggle.

This desire of novice teachers to meet multiple demands was expressed in other ways, and pervaded accounts of the entire data analysis. Almost all described a desire to be in two places at once in order to meet the needs spread through the class. Gina Hunt described trying to meet the different needs of different students simultaneously, to surpass her limitations, as a felt need to be more than one person. The researcher noted this was no abstract description, a solution imagined after standing back from events, but of a felt experience (of "templates") in a moment of multiple mental applications:

> but the challenging part is that you're one person. So while I'm teaching templates, if this one student goes over here, I cannot break out of my body and go send one of my self over there to keep her on track. So it's always this picking your battle, how much, because she's [a wandering student] not supposed to sit in the library. She's supposed to sit with us at the carpet. You feel like you need multiple bodies to keep it all going, and sometimes you lean on that pacifying."

During her account, she relived the scene of a student breaking out of the group ("one student goes over here"), her attention being split toward this student (what she was supposed to do), and her circle of students. She felt herself pulled into multiple bodies. This experience of wanting "multiple bodies to keep it all going" was not unique to her. Kevin Long described a similar experience of wanting to be several people at once: "Yeah. Just a lot of different things going on at once that I want to address. . . . There's all these different things happening that I want to be able to copy five or six of myself to where they can all go and deal with all these little tasks." Unlike his description of taking apart the complexity mentally, given above, here he himself was taken apart to deal with five or six things. Gina Hunt also described not having enough of herself to spread, also in the context of her learning. It was herself and the learning that was spread. The beginner was faced with multiple learnings all happening at once:

> There is so much learning that happens in the beginning, it doesn't feel like you're making as much headway on mastering because you're spread so thin across so many things. It's almost like the goal in the first five years is to spread yourself over as many things as

> you can to have a little bit of information about many things. And then after you cover that ground, you get to start going deeper . . . you're learning so many things at once that you can't master anything because there's too many things and you can't—you just don't have enough of yourself to spread, if that makes sense."

The transition was from little bits of information to going deeper. "Learning so many things at once" again evoked the "at once" so many teachers used to describe the many happenings needing responses. This image was of a classroom teacher being extended over an area, stretched thin. While it may sound as though it was a self being split or spread, the context was always on a self performing multiple tasks, the performances meeting these tasks. The statements *there is not enough self* and *there are not enough performances* seem to equate. Self and performance were one here, and both were divided. She also evaluated her learning, that the amount and daily immediacy of things to be learned prevented mastery of "anything," or, as she indicated elsewhere, really deep learning. Her words described a sensed limitation of self, of a self's performances, of her learning within the experienced environment, and a desire for learning that pushed back these limitations. What would bring that really deep learning? In these three descriptions there was an external and internal complexity of simultaneous things happenings that gave rise to a longing for multiple selves and performances, an environment that spread the self out, a self who reached out to be "enough" to meet the demands, and of demands not being met due to this specific complexity.

Recurrent and continuously operating skills were often described, and by all teachers. Several teacher skills were described as so recurrent and continuous that they emerged as powerful themes for understanding simultaneity. Practices like noticing or tracking, or skills sets for engaging students were always being described in tandem with other performances. These seemed to constantly occupy a place in working memory and their concurrence with other tasks there became relevant for teacher learning design; all teachers expressed that they really wanted to learn these two tasks because of their constancy. The skill of noticing, or cognitive processes that increase classroom awareness will be the focus of the next section. Engaging the entire classroom was described as operating simultaneously and continuously as well, the goal at least occupying a constant place in working memory. Gina Hunt reconstructed this experience of simultaneity during a teaching technique called "templates." As she was observed, she led the group in a kind of chant over the vocabulary words, the teacher and students taking turns, and she signaled students and tracked responses at the same time; she described what was happening unseen:

> So, you're watching for engagement. You're watching for all those things. And so, as I'm doing this call and response, this other part of my brain is watching kids that are or aren't, and I'm strategizing how to pull them in. So, "my turn, your turn," and I'm doing this thing automatically with templates, but I'm watching. "What do I need to do to get these four kids in?" And it's different every day. It's different depending on what's going [on]. . . . But keeping them engaged is key to having that be successful. So your mind is teaching, and you're also strategizing engagement the whole time.

She indicated that it was another "part of [her] brain" that was "the whole time" strategizing engagement, always tracking students, even as she was enacting her templates "automatically." She also distinguished the recurrent "keeping them engaged is key" from the nonrecurrent, "It's different every day. . . depending on what's going on."

Gina Hunt also described how simultaneity impacted her mental effort during learning, what it was like to include a new skill, to have "clarity" as many complex things were happening simultaneously, and her own anxiety of introducing that new skill within the simultaneity demanded in teaching. Like other teachers, she was describing what it was like to be "in the moment" of learning and problem-solving, what it was like to reach for the new resource she was practicing.

> It takes a level of consciousness to even be able to bring that [new tactic] into my brain to use it because my natural response is to address the talkers. So, I have to have a certain level of clarity in the moment to even pull that. It takes energy for me to have a consistent level of clarity where I can even stop and think about, "No, no, no. Remember you're working on not doing that [particular habit of teaching]." So, the higher that fight or flight response gets, the less clarity you have, which means you're not going to be digging into that bag of tools that you're trying to use. So throughout that 30 minutes that you [the researcher] were observing, or 40 minutes, I would say that level of clarity was decreasing because the more things that were getting thrown into the mix, the less likely it feels like you are to be able to reach and use a tool that you're trying to use because you just lean on what's natural.

Again, this was a novice teacher creating language to describe fluctuations in her mental effort, surrounding the experience of "pulling" something new from the "bag of tools." This bringing something new took "consciousness" and "clarity in the moment" and her "energy" was focused on maintaining this mental clarity. She coached herself in that moment, "No, no, no. Remember." She was aware of her clarity diminishing with increased energy spent, with things that were getting thrown in the mix. She was introducing a skill while simultaneously performing other skills. As her level of clarity in the face of multiple needs decreased, her "digging into that bag of tools you're trying to use" for the skill she wanted to introduce, became inaccessible, and she turned from the tool she was trying to use to what was a “natural” response, the available response that memory offered more immediately. She felt like she could not reach it. Ella Finn also described her mental resources, and spoke of her own bag of tools as she reached for them “in the moment.” A teacher coach had freshly added to this collection of resources, giving her new things to “juggle.” The teacher coach focused on a specific moment of her teaching, and gave recommendations on the skill of “prediction.” Hunt described the list:

> I had a debrief yesterday on my formal observation, which happened Wednesday, and there were some great questions that [Name redacted] had for me. But they’re essentially around this topic of seeing it happening, juggling how to fix it when it’s happening, knowing something happened, and thinking about what you can do to fix it in the future, but then knowing it in the moment, pulling it out of your pocket in the moment to fix it before it happens, or to make more out of it when it does happen. . . . Knowing that’s coming, I know that’s coming. But I have so much going on up here [in the mental process], that that’s a lower level of priority. That’s a lower piece for me, and all the rest of it is just more to think about. And so it would’ve made it better. So that’s a note to self [laughter], if I can remember to pull it [prediction skills] out. Right?

Finn, like Hunt, had a bag of tools to which “prediction” was added, and there were multiple ways given to think about this skill. The tool was meant to be accessed “in the moment” when knowing it, pulling it out of your pocket, making sense of it would happen. The moment demanded immediacy of the tool, but the amount that went on in her mental process, in the moment, forced her to arrange her tool bag, to prioritize and decide prediction was the “lower piece” and to consider the rest of the reflection from her observation “just more to think about.” She had been given the complex elements of prediction, elements to be judged in the moment, while simultaneously doing other things to teach the class, but all these elements she gave a "lower level of priority" based on the amount of things that were still going on "up here" in her mental process. The level of mental effort impacted the arrangement of her tools, and pushed many of them to the back. Gina Hunt described the frustration of teacher-learning as an activity simultaneous to lesson delivery, behavioral management and inclusion. It is important to note here that she shared this in the midst of reconstructing actual events, real situations she had navigated in her classroom; it was not inclusion she was against nor differentiation, but she was commenting on the difficulties of learning, of practicing new learning, when multiple performances were demanded.

> Interviewer: You're trying to learn something. You're trying to maybe work on a new skill, or—
>
> Hunt: Yeah. I think one thing that really hinders a new teacher's ability in the beginning, if we're to be expected to master the curriculum and teach it, we can't have so many behavior distractions. And so, inclusion, this whole idea of inclusion is super-disruptive. So, we're given this task of mastering curriculum, and also managing behaviors simultaneously. But they really don't— it's really tough. Those are two very polar opposite masteries. And so, when you're trying to focus on teaching a lesson to 25 kids and you've got [several] autistic students, [several] ADHD students, with all these things popping like popcorn in your classroom, it does hinder your ability to just get through a lesson. . . . I understand that there are two things you have to master, but sometimes all at once—I think, "Is it better to give a novice teacher a lower behavior load in the beginning?" because that way [novices] can focus on one or the other and then slowly up their behavior management group.

Once more, there is a critical stance toward her learning environment, and its source is reconstruction of her mental effort in recurrent skills. Multiple masteries in the moment of teaching students with real needs split her apart. But this passage is important for this section on simultaneity because of the recurrence of themes between this account and others already reviewed. She evoked the “many behavior” issues. She gave an inventory of other issues coming up while “managing behaviors simultaneously.” She gave a vivid description of “all these things popping like popcorn in your classroom.” The many things needing to be mastered, must be mastered “at once,” a phrase reiterated in teacher descriptions of the classroom and its unique complexity repeatedly. There was a desire for learning here, for mastery and “focus”, but the lack of focus “on one or the other” set of skills was the frustration. The environment was the challenge, and eliminating some of the complexity, according to Hunt, would help the learning.

Structural synthesis. Teacher mental effort was directed to many different objects at once, intended multiple skillful responses and performances at the same time. All of these anecdotes expressed a level of urgency, a desire to fulfill the many demands at once, and communicated a type of skill level and instanteity of performance demanded by the classroom. Listening to teachers again and again evoke the complex simultaneity of the classroom forced the researcher to reconsider the meaning of mental effort teachers experience. The researcher approached this study with a concept of CL as a quantity of mental effort in working memory, the number of steps in cognitive processes that solve a complex problem. The construct has been used in quantitative tests of specific learning designs, and employed in controlled experiments, but the researcher sought qualitative descriptions of CL when the classroom was the teacher-learner’s environment. In controlled experimental environments, skills can be isolated and conditions of learning monitored; the classroom does not offer such a luxury. As teachers described their mental and physical performances, simultaneity emerged as an invariant constituent unique to teacher CL, and a major theme. First, it should be noted that in all of the above accounts the classroom is considered a learning environment, the place of learning. This is where teachers learn, according to teachers. Teachers expressed a desire for simultaneity of skills, as in the case of Amanda Betz, but all teachers including Betz indicated that their learning and problem-solving were challenged by the classroom and its multiple happenings, that the classroom interrupted important cognitive processes teachers were implementing. Reconstructions of mental effort "in the moment" made teachers aware of these challenges.

In the complexity that is classroom teaching, just as novice teachers experienced many things that were happening at once in the environment, there were also simultaneous processes and decisions occurring in their working memories. Simultaneity occurred on many levels, but three were iterated in descriptions. First, teachers experienced simultaneity in *the classroom environment*, when different problems or objectives arose at the same time, such as students needing redirection while the whole class was transitioning to a new activity, even as a teacher needed to switch her materials. Second, teachers experienced simultaneity in *teacher performances*. For example, as teachers gave lectures or directions, they tracked multiple student physical and verbal responses and strategically moved through the class, doing three things at the same moment. Third, simultaneity also was also experienced as *cognitive processes* that teachers described as happening concurrently, "at once" or "at the same time" in numerous accounts.

Teachers could not change the first two, the environment and the types of performances that the environment demands, but could only develop processes within the mind. However, these changes had to provide the simultaneous performances for the environment of concurrent demands. The need for change was experienced as levels of mental effort to grasp the tools, the resources that made the performances happen. Reflecting on mental space during problem-solving, on the limits of memory, always returned them to the environment and the performances demanded, and descriptions of the ever-present complexity of simultaneity, mental and otherwise. Betz's description, "there's more things going through my brain" in describing the effort of doing one skill was not unique. Multiple things happened, "in one swoop" for her, and for all other teachers there were multiple happenings in the moment. All of the teachers were engaged in constant "swoops." The new activity, the skill teachers expressly desired, was a way to put all skills together at the same time, in the moment. But what did that skill look like for the teachers?

They described multiple processes, in the moment. For the researcher, it seemed like a lot of processes went through teachers' working memories concurrently, and one of two choices seemed possible: (a) the descriptions were the result of later analysis of the problems related to skills and the teachers reflectively took abstract skill apart in the interview, or (b) many thoughts or processes actually did occur simultaneously, as teachers staunchly affirmed, and their later reconstructions only seemed like post-reflective analysis. Again, if the latter choice was true, how was it possible? What did it look like? Teachers described this mental simultaneity in two ways. First, as thought processes *happening consecutively, at great speed*, the latter as though steps of skills had to be broken apart, arranged, prioritized, lined up consecutively and thought so quickly, in that moment, that simultaneous performances could be maintained. But they also described *concurrency of mental processes*, an "all at once" and "at the same time" in reference to processes, seeming to affirm they happened side-by-side. Were the resources and cognitive steps *lined up* or were these *stacked* in memory?

Reconstructions of mental effort, many of which have yet to be covered, seemed to treat the problem pragmatically. At times, when teachers described high mental effort, the "all at once” became impossible, and frustrated teachers knew it and described it. When they described automaticity, the “at the same time” of moments of simultaneous enactments became possible and teachers were satisfied. Reflection on mental effort in specific skills exposed, consistently, the simultaneous demands. The goal of automation, having a skill down, being able to do something “on the fly” resolved the issues, and was often the stated goal of learning on one’s feet. But automation, however one conceives it, does not resolve the problem of consecutive thoughts at great speed verses concurrency. If skills of a teacher are automated, they may be concurrent and also may be extremely quick enactments both. Does the arrangement of information, resources and performances matter if the pragmatic goal of learning produces the performances that meet the simultaneous demands?

Teacher learning and levels of effort seemed fused to this simultaneous environment. There were moments in teacher description where movements and changes in the environment were accompanied by fluctuations between automaticity and intense focus, intentional thinking-out of steps, and immediate activation of responses. Teachers moved from one instance to the next, environmental and cognitive, and distinguished prior levels of load from others by instances of change in levels of the simultaneity demanded. CL in this environment was not a group of consecutive instances, discrete happenings, but was a pervasive, fluctuating reality, a teacher being moved and moving, expending effort and having it pulled. Just as the mind and its processes never disappeared from the classroom, so the experience of limits that accompanied processing never disappeared from the classroom, but underwent a constant fluctuation. There were singular and unique snapshots of mental effort in this environment of simultaneity, and mental limits were like the constantly widening and contracting lens of a camera that had to be adjusted due to constantly changing levels of light.

One other element of simultaneity that became apparent was the interplay of the recurrent with the nonrecurrent elements of teaching. Nonrecurrent elements of teaching would include how one presents a specific lesson within a curriculum: the lesson or mental performance is taught for one or two lessons in a 180-day year; or it would relate to how to differentiate that specific instruction, or how to walk back a particular standard in a lesson design. While presenting a curriculum and differentiating instruction and standards-based learning occur with most lessons, the actual content involved and the cognitive processes used to present and evaluate that content must change each day and hour of each day. Recurrent elements of teaching were performances such as noticing or engagement practices or giving consistent directions with effective elements, or transition skills. The researcher was able to distinguish the two types in novice anecdotes, and noted how recurrent skills described by novices as automated also supported nonrecurrent teaching practices, and teachers often described the need for automating the recurrent. Usually they called these recurrent practices "classroom management" and skills traditionally associated with this category of teaching skills are often recurrent. A nonrecurrent lesson would demand circulating, redirection of students, constant noticing, for example, in order to keep the lesson moving. Recurrent skills could be classified as supportive when simultaneously done with nonrecurrent instructional delivery practices, based on novice accounts of simultaneity, and especially of noticing, covered in the next section.

How are dual-process models of cognitive psychology to dialogue with this simultaneity? The study of working memory does establish how many items a person's memory can hold, the number of objects and processes that can happen there. Long term memory develops complex, multi-step processes into strands, and even though the entire process must still be carried out, it is "chunked" and performed "in the moment" where it is treated in working memory as a single item, as opposed to multiple steps. Whether different items are *lined up* or *stacked* also seems unresolved, although theorists most often speak in terms of speed. However, the researcher could see circulation happening during a lecture and the redirecting tap on a desk, all three at the same time. Can something happening in long-term memory be concurrent with the working memory event? Perhaps teachers might add to their views a concurrency. Perhaps a more important question would be, Does it really matter if each mental event must be lined up consecutively or stacked in this complexity? Mental simultaneity always appears to be resolved through automaticity and hindered by increased mental effort. It may be enough to know that automating specific skills reduces CL in this environment, as the participants described.

In any case, teacher learning was about negotiating simultaneity. Simultaneity as characterizing the environment and mental processes pervades not only the exemplars above, but all descriptions of teachers that follow in this study. In terms of levels of CL, simultaneity very often produced overload in novices. However, the teachers' success at learning while undergoing high CL, their development of automaticity, depended on their navigation of simultaneity. The fluctuations due to simultaneity impacted the learning. The learning also impacted the fluctuation, brought the change teachers wanted; they perceived it as resulting from trial and error and time and experience, but the change was always the same: how to deal with the "at once" of multiple needs and tasks in the mind. As something became automatic, it seemed absorbed into this simultaneity, it simply happened while the teacher also had to work at making newer things happen; and this was always the case. They acquired a habit, a skill or resource, and immediately were presented the next thing. Teachers were not so much frustrated at simultaneity as at the learning demanded for concurrent performances. These thirty kids every hour were what teachers seemed to have signed up for, and they embraced them even though struggles to perform broke them into pieces. Some expressed simultaneous demands as a crushing weight and lamented their lack of techniques and tools for dealing with it, their limits. In terms of types of load, simultaneity could create a germane load, such as in the case of Amanda Betz learning to circulate, or, more often, it reduced learning and was a distraction, producing extraneous loads.

Noticing and simultaneity. Certain simultaneous classroom performances and simultaneous thinking were pervasive elements in teacher accounts of their cognitive processes and classroom performances. Nowhere was this more evident than in descriptions of the skill of noticing, or tracking student engagement and responsiveness. In this section, teachers describe the mental effort of noticing, a performance, as it converges and navigates complex simultaneity. Acquisition of noticing as an active skill kept coming up in each interview, and accompanied all reconstructions in one form or another. Novices marveled at expert noticing skills, the awareness possessed by veteran teachers. For participants, a huge piece of the disillusionment of entering a classroom was the discovery that they hardly could tell what was going on in their classroom in their first months, and that noticing was an active performance and an art, a mental effort that persistently accompanied and was simultaneous with every other skill. Novices tracked happenings in class that triggered techniques, and they tracked students to measure the effectiveness of teacher performances. They tracked their students, and, at the same time, their own cognitive processes, their own levels of skill acquisition, all through noticing. Novice teachers described increasing acquisition of noticing, moving from noticing what happened in the classroom to noticing how and even why things happened as noticing evolved into prediction and anticipation. Novices were jealous of experts who had the skill, as exemplars will demonstrate below, and the acquisition of this skill was a constant obsession for them, implied or explicit in almost all classroom experience descriptions, a desire that the skill of tracking students would be more refined and continuous and effective. Novice teachers expressed again and again their desire to be better at noticing, that noticing should become an unconscious, automatic ability, and described how noticing impacted other simultaneous activities and was itself impacted by mental effort.

The skill of noticing or tracking students is also a significant example of conflicted communication processes. Teachers were often faced with the task of overcoming the limits of discourse. Noticing provided the best exemplars for this. The reality of noticing, its lived experience, stretched the limits of discourse because it was an awareness skill and awareness in the classroom requires multiple directions, and also because it was performed simultaneously and constantly and occupied an ongoing place in working memory even as other processes would come and go. Noticing accompanied every other skill, and most intensely, according to participants, when skills were being introduced. Two ways novices described noticing were through the use of analogies, and also communication that layered the single moments of classroom performance. Analyzing both noticing and the ways of communicating this skill occupies this section.

Textural synthesis. Ella Finn communicated how she experienced the skill of noticing through an analogy she constantly returned to. Her noticing ability fluctuated depending on how the level of distraction increased her mental effort, in an ever-widening and contracting "circle of vision" that she learned about while being a rafting instructor:

> Finn: I feel like there's things I'm not attending to because I'm caught up in whatever this frenzy is but I'm not necessarily able to attend to other things outside of that.
>
> Interviewer: Okay. What's that like? Is there just a—?

> Finn: Let me think. Well, probably the feeling is just that I need to step away for just a second. I need to step back and—kind of like I've prioritized this as too high and I need to step back and be able to kind of be up here rather than right here. So [that] my circle of vision is just one or two people instead of a 30-foot radius. . . . I think about it a lot. I compare it a lot to—I used to teach people to raft. I used to teach people how to row boats and read water and stuff. And for the first couple of days, there's just too much data they cannot see more than five feet around them. They're just in this frenzy of trying to figure out what to do right just in this little circle around them. And then once that becomes kind of automated, "Oh wow. Oh, there's a deer on the shore, [laughter] and it might have been there a few days ago, but I didn't see it. But now I can see outside of that circle in a bigger radius.

This was a learning analogy for what happened with other skills when one skill became automated. She began her reconstruction with "being caught up" in what she called a "frenzy" of working with students in her immediate focus, and how she was unable to split her attention between these students and the larger class. The mental effort involved was something she thought about "a lot," and she gave an analogy that described where she has gone in her learning. In the beginning, there was "just too much data" and the focus was on the basic tasks before her. She was limited in her noticing skills, limited in the amount she could see. "Once that becomes automated" she saw more, being able to process more information, she widened the circle. The immediate focus, what was happening in "five feet around them" was a frenzy "trying to figure out what to do." But automation widened the circle. She continued, describing what happened in her classroom when added mental effort from the distraction of simultaneous events narrowed her Circle:

Finn: Yeah. And so I see it the same here where when it's calm and it's not like a rapid. . . . I can kind of see and observe everybody here and I can—but when they [a group of students who surrounded her desk] were all up here, I felt like it was a rapid fire, and so I couldn't really look out of my little circle because there were five or six of them all lined up, and they all had an urgent need and urgent question, and I was trying to satisfy all those needs and questions, and I felt like I was panting and breathing hard because I was running or something. And so I couldn't see in that bigger circle of vision, which I think is super-important. . . . I mean, it's like driving a car. I mean, when you first learn to drive, you're like [gesture, focused on a small area in front of her]—but when you can feel more comfortable, you can see in that bigger area. So, I feel like I need to get better at that piece or facilitate it in a different way.

Interviewer: Okay. It's a skill. . . . For teachers, it's an active skill. You need the teachers with eyes in the back of their heads—

Finn: And I don't have that. I mean, I had kids come in and say, "Everybody loves your class because you let them be on their phones." I'm like, "Really [laughter]? I do?" And so then [they said] "Yeah, it was so and so and so and so." I was like, "Oh, okay, cool. Thanks." So then when so and so and so came in that period, I totally nailed them because I was attending to that.

What was being described here was high mental effort in a moment of simultaneously working with students and monitoring the class. Ella's "Circle of Vision," her noticing, fluctuated for her, as it was impacted by classroom distractions and levels of mental workload. When she was in the midst of the frenzy of paddling and avoiding wrecks, she was unable to see the deer on the shore, unable to monitor the class. She used the analogy again, in this next account, to describe whether or not she could see a technique or solution to a problem. She herself was the rafter, learning to paddle, and here the analogy was applied to all her learning and not just noticing. The "Vision" that fluctuated was interior, mental. She was looking for the deer, again, the skill of prediction, and could not see it or find it in the moment. In this account, she described her mental effort and frustration at utilizing her prediction skills. She began by referring to the simultaneous issues in her class, her "juggling", and powerfully described her teaching, a frenzy of paddling around wrecks and chasms, and how it impacted her "Circle of Vision":

> Finn: Yeah. And [those skills] are just a little bit farther down the priority list. And I'm juggling some other things that are newer and so I just feel like I have to get better at using them. And I feel like I'm not there yet. I don't know if that helps.
>
> Interviewer: It does. It does.
>
> Finn: But it is kind of like the deer. I mean, again, it's that circle of vision.
>
> Interviewer: You've got the water rushing around you [laughter]—
>
> Finn: You can't see—
>
> Interviewer: —and you've got this beautiful deer that you've seen before, and that you know about, that's predicting how the group's going to go. It's—
>
> Finn: Yeah. But you've got this big wreck ahead of you and you can't see [the deer] because there's too much going on.
>
> Interviewer: Having your focus up on the board. You've seen that deer before, but it's—
>
> Finn: You can't see it because there's this big chasm in front of you, this wreck and you've got to navigate through it before—and it's already by you by the time you—the deer's out of your view shot now, so you can't see it.

She bagan with prioritizing skills, in the midst of “juggling.” Prediction was not available to her and she questioned how she could make it available, but it was farther down the priority list. She was reaching for the deer, was aware that it was there, but it could not be grasped. The last sentence indicates “the moment” in which such grasping took place, how one must act before the moment slips away. In another part of the interview, she described classroom events and processes as pushing her into a “tunnel” where she could not see the next step. This ever-narrowing and widening Circle of Vision, which contracts or expands depending on distractions in the class was an analogy for fluctuations in mental workload as these are constantly attached to noticing. It was a learning analogy that brought together both mental effort and grasping for the resource she needs. Could her mind process this new information, see the deer, while simultaneously dealing with what was right in front of her? As mental effort increased (e.g, the rapids grew more treacherous), resources for tracking the classroom diminished (e.g., the “circle of vision” grows smaller), and a larger view was abandoned (e.g., the deer could not be seen) as the steps for other processes dominated her working memory.

Gina Hunt, along with other participants, described the simultaneity in teacher practice with the analogy of “putting out fires,” but also gave an analogy of her classroom as a map of forest fires that needed to be put out. It was an analogy of noticing classroom problems and making decisions with the information, but also about mental effort and how it fluctuated for her.

> If you can kind of imagine in the summer time, sometimes you see a map of area that’s being hit with forest fires. The firefighters focus on the major areas. Often there’re these little fires happening all over, and they’ll get to them when they get to them, but it’s kind of like you hit the major fires. So, every day, I feel in some ways my classroom is a map of fires, and you spend your time moving from biggest priority to smallest priority. . . .

> I'm just moving from fire to fire. [Name redacted] is a fire that will sprout, and then you put it out. And then it will sprout, and then you put it out [laughter]. So it's one that never really goes away. So yeah, that's what it feels like.

The classroom was this map of fires, constantly monitored, and the firefighting "never really goes away." (Later on, she would celebrate an earthquake drill, which made the researcher wonder if she was attracted to teaching for the disasters!) When asked in another interview how her experiences of teaching had changed her view of learning to teach, she returned to the analogy to describe a change in her noticing,

> Back to the fires: you know that going into teaching, there's a lot of things that you're going to need to do. You kind of quickly learn that the bigger fires that are the most out of control take you attention primarily. So I think that month one, I'm looking at every single fire on the map going, "What's happening? What do I need to do with it?" Down the road to today, I know which ones are going to be the most active, so therefore you're not running around every fire.

Similar to Ella Finn's analogy of the circle of vision, Hunt described her "looking," how her view of "the map" changed with her increased learning. In her early teaching her focus was on every little fire, but she had acquired a larger view, she saw more, knew the important problems she was looking for and she could respond. The skill of noticing was more immediate and available within this simultaneity. The challenges were still there, the map appeared unchanged, but how she was able to prioritize the most active and make judgments, her cognitive process, had changed. Analogy again brought together mental effort in noticing and the simultaneous complexity of environment, performances and mental processes.

The other path to communicating simultaneity was a layered description of events and information; these descriptions were chaotic amalgams at times, but the researcher remained open to the entire horizon of the experience. Amanda Betz described how she saw herself improving with reference to the skill of noticing, offering different instances. It is important in reading this description that one sees her as she saw herself, mentally re-living the experience, standing in front of a class as 35 students sat before her, a massive source of information, movement, and what she called "white noise" that needed interpreting.

> Betz: I'm constantly looking and seeing, okay, who's having a bad day? This person always faces me and today they're hunkered down trying to sneakily text, or they're on their laptop, or they're heatedly whispering to their neighbor. There are those physical tells that I feel I'm getting better at picking up on.
>
> Interviewer: You're noticing more.
>
> Betz: Yeah, which hopefully will become just automatic and I'll know it instantly. I mean, I feel like some teachers can tell by how they walk in the door if it's going to be a good day or not. And I'm not there yet [laughter]. But after 3 or 4 minutes in class, if I really pay attention to what they're doing, I can tell, okay, something's up with them.

There was a significant amount of information to process, and she gave her inventory of questions and targeted behavior examples. When the researcher described it as growth in the skill of noticing, she immediately described her hope. Noticing would "become just automatic," and she would "know it instantly." She described this hope in terms of mental effort. Other teachers had this instant knowledge, she said. "I'll know it instantly" was a description of what the memory of a teacher could do, and the speed at which it could be done. The multiple steps are made one step, an instant happening. In reconstructing her mental process during the lesson, Betz gave the following description of her noticing. In this and in other accounts, she surprised the researcher with the amount of questions and information that occupy her mind in a limited time-frame, in the moment, as she was walking her entire class through mathematical problems.

> Betz: I was trying to think in my head, "How can I get more enthusiasm with this? I'll have to change this up next time I teach it." And I know some of them have a fine time staying engaged, but others need something like, I don't know, every 2 minutes, something new for their brains for them to stay on task. So, I was trying to think of how I could change it up next time and some kind of interactive worksheet or guided notes even or something that they would have to pass around the tables. I was trying to think like, "How can I do this in a group setting?"
>
> Interviewer: Were you thinking of it during the lesson, or [later]—?
>
> Betz: Yeah, when I was walking around. And even as I'm lecturing, I'm talking but I'm also thinking, "Oh crap. They're just staring at me. How am I going to change this?" And I felt like that towards the end of the lesson. Not necessarily specifics of how I could change it but just knowing that this was not as successful as I wanted it to be.

She was lecturing, noticing and searching for the technique, evaluating her own performance before it was even done, her simultaneous efforts. She was talking and strategizing, and then noticing engagement. She unpacked her inventory of thoughts, but affirmed again the doing of things "at once" as she walked around. In the following account, she related an automatic level of mental effort in offering one-on-one help to a student, perceived by her as automatic because she was scanning and tracking her class simultaneously. She was asked about things she does automatically, and gave her own description of noticing that included simultaneity:

> Betz: When I do something automatically, I don't think I think about it, so it's probably hard for me to reflect on it. But there are definitely things that I started doing that I don't think I think about as much. Like when I bend down and talk to someone, I do feel like it's automatic for me, and I hope the student doesn't think it's rude. And that's what I also worry about in my head, "I hope [Name redacted] doesn't think I'm ignoring him because I really am listening with my left ear. I'm just using my right ear and my eyeballs to look around." So that's what comes to mind the most when I think of automatic. I'm just always scanning the room with my eyes to make sure no one needs me, to make sure no fights are going to happen, there aren't cell phones.
>
> Interviewer: So automatic would apply to the skill of noticing?
>
> Betz: Yeah.

Again, the image of a teacher in pieces was prominent, the splitting of the left and right side of the head, eyes and ears going in different directions. Moreover, it was a glimpse of her own automaticity that made possible simultaneous tasks, expertise that she hardly recognized in herself. She was actually self-conscious about her automaticity, was afraid a student would consider it rude, being split between the student and the rest of the class at the same time. This was, again, an anecdote produced by a teacher reconstructing her mental effort and measuring the skill she was constantly grasping and her mastery of it.

Betz also gave this description of a new skill, how she implemented "a brain break," a directed transition to a physical activity that cleared students' heads, created a little chaos, then involved getting them back to work. Here, the skill of noticing required greater mental effort. Her mind strove harder for information when she performed a skill that was unfamiliar to her:

> Betz: When I do something that I'm still working on, I feel like I'm even more in tune with how they're reacting to me. So, with the brain break today, I was constantly listening for gripes, listening for people saying, "Oh thank goodness." I was listening for the sigh of relief that they were done for just 20 seconds or listening to the complaints. I feel like on that front when I'm trying something new, I'm much more attentive to how they're taking it versus if it's something that we always do, I'm probably not as attentive. I was when I first started that thing [the "brain break"], but once it became automatic, I don't think I'm quite as attentive.
>
> Interviewer: But the new thing— you're constantly monitoring yourself and then second-guessing?
>
> Betz: Yeah, second-guessing if it's right for that specific group of students, but mainly watching their body posture, their facial expressions, their language, just to see, is this working or should I just dump this [laughter]. That's really what I'm trying to figure out. Was this horrible, or could I refine it [so] it becomes automatic? Could it work in the future if we work out our kinks together?

The first words of this description presented an interesting glimpse of mental effort. A new skill, she said, one that requires greater mental effort, also demanded more effort in noticing, with "being in tune" with the class. Betz described here the shifts in her levels of mental effort, her sense of effort in noticing during both a new and an automated set of practices. Noticing increased as a new skill was introduced. The steps of the skill were harder, and the attentiveness was more intense. In her last phrases, all of this was placed in the context of Betz designing and refining her own learning, how she might make something "automatic." It is important to point out that her descriptions of her experience were based on an entirely new experience: looking at her practice with levels of mental effort in mind. This shift in awareness brought her, and the other teachers, to make connections, to note how their practice was working on a deeper level. In her third interview, Betz talked about how the classroom was helping her and was asked about all the things that went through her mind during teaching, which she had described in the first two interviews. It is notable that she instantly focused on perceptiveness, her "picking up" on things to answer a question about all the things going through her mind, her simultaneous processes. She described the change in her mental limits and simultaneity with reference to this one skill.

> Interviewer: You were talking about all the other things that go through your mind and those keep recurring. Is that always going to be there, do you think, or will that change? I mean you're handling all these things that happened.
>
> Betz: Man, I think they might change, but I don't know if we'd use the word get better. I feel like I'm more perceptive now than even in the first couple of weeks of teaching. I don't think I was picking up on a quarter of the things that were really happening in my room because I was so self-focused, and nervous, and scared to be a teacher for the first time. And now, I feel like I'm a lot more calm as the teacher in the room. And so now, that lets me kind of use more of my attention span or my brain to be checking in with them. So, I don't know. I do think it'll change, but maybe it'll just get more not-overwhelming. But I bet you, if I walk into a room and Mr. [Name redacted] walks into a room, who's been teaching for 35 years, he will probably pick on different things than I did.
>
> Interviewer: So, you're talking about the skill of noticing.
>
> Betz: Mm-hmm. . . . I think hopefully, I'll get better picking up on—I don't know—body language, facial expressions, people doing something with their technology that

> they shouldn't be, people growling tummies and they need to go down and get a granola bar, whatever it may be.

This teacher described simultaneous or concurrent cognitive processes. Her growth was described as being calmer in the classroom, and she said she could use "more of my attention span or my brain to be checking in," connecting her larger attention span with a larger mental space, or more of her brain. She had not been coached into this answer by a CL theorist but was simply looking within and describing her progress in terms of mental effort and what the researcher would call a mental economy of skills. The increasing automation of certain recurrent processes, their becoming instant, as she described earlier, would allow other processes associated with attentiveness to be performed simultaneously. An interesting nuance she gave to her learning was that she would not speak of "getting better" but of making things "not-overwhelming." "Overwhelming" was a word she often used to describe situations of higher mental effort. The change that learning brought, she said, would reduce her mental effort. "Better" was changed for her to "not-overwhelming," so better was expressed in terms of mental effort in this assessment of her learning. She also made these observations about perceptiveness and noticing in the context of a question on mental process simultaneity and complexity. She also described, in a very nuanced way, fluctuations in mental effort, moving almost effortlessly into her description of the levels of load. Like Betz, all six participants found the words to describe fluctuations in mental effort, and they moved very easily through such descriptions of fluctuation as it accompanied events.

These exemplars will not be repeated in the following sections on automaticity, but they also apply to those textural descriptions. These descriptions are given here because they have complex simultaneity and the skill of noticing within the simultaneity of mental processes as a focus. The expressed need for automaticity, the need to decrease mental effort in the skill of noticing especially in order to navigate and manage complex simultaneity was an invariant constituent.

Structural synthesis. Noticing served a structural analysis for how teachers communicate the simultaneity of cognitive processes. Such communication became problematic for this phenomenological study. A reflection on the paradox of communicating the experience of simultaneity and complex happenings is in order. At multiple times in the interviews, the observed classroom events were isolated for description and reconstruction, and the researcher listened as novice teachers took apart the minutes and even seconds of their experiences of CL. During these times, teachers would seem to be back in the moment, their eyes focused on some other place than where the interview was happening. Especially when describing moments of cognitive overload, teachers seemed to tear mental events into pieces, separating and spreading into narrative the layers of thoughts that passed through their minds. As with Amanda Betz, in these moments the researcher silently questioned participant accounts, repeatedly wondering, "Did all of these things pass through his/her mind at this particular moment?" Or, "How could so many different thoughts and decisions go through his mind in those seconds he was frustrated with his projector, redirecting his class and delivering his lesson?" Every teacher was given the task of expressing those seconds of cognitive overload and met the struggle with composites of thoughts and actions. Participants grappled with moments of perception and memory and at those times seemed to be doing reflective analysis and not conveying prereflective experience. Their grasping and turning over items and sifting through multiple layers of judgement and action and performance and information processing might very well have been a teacher expanding on the experience, re-processing and re-analyzing what occurred in hindsight. In other words, the events described might not have been a reconstruction of the lived experience itself.

It also occurred to the researcher that his critical stance could be a prejudice that results from human language itself, due to the limits of discourse. The need for a structural analysis of these accounts emerged. The researcher needed to consider what was being communicated. In lived experience, working memory treats long-term memory schemas, extensive processes with multiple steps, as single items. CL may be an experience of four or five items (some items being large long-term memory schemas) passing through the working memory at once, at either a high speed, consecutively, or simultaneously. If this is the experience, how can this be communicated? How is a novice teacher to articulate not one experience or mental process, but three or four, all occurring at once? Teacher accounts pushed against the prejudices of the researcher associated with discourse as he watched novices pushing through linguistic barriers.

Cognitive phenomena, the real mental events as they occur in the mind, are not merely streams of consecutive words moving along in a narrative form, nor do mental processes follow the same order as found in discourse. Discourse is just one mental process, a way of modeling reality in a single stream; if the reality is multiple streams of concurrent mental processes, discourse reveals its limits. While discourse must reduce and convey events in words and expressions according to linguistic conventions, the concurrencies teachers actually experienced had more magnitude than this. Reality is richer than description. Listening to accounts of teachers trying to describe lived experience of simultaneity and mental effort demands that the listener be aware of these limits. *What-happened-in-the-moment* cannot be packaged as consecutive events, as normal discourse. A teacher with many well-developed long-term memory schemas interacting with working memory in a disrupted classroom may have simultaneous elements occurring that completely defy traditional discourse, that defy the prejudices associated with narrative. The researcher realized a need for a new type of listening, one that unpacks simultaneity and complexity in mental effort.

"Could a teacher have so many thoughts at once?" arose from answers to the question, "What happened?" All teachers gave analogies as answers to the second question, or layered descriptions of separate thought processes that occurred in the moment. The complexity of the experience demanded a different discourse. The horizons of the experience were beyond traditional discourse. In the researcher's experience, masterful and expert teachers he has known have found it impossible to express all of the moments of their most complex classroom navigations, those moments they both brought order and pushed forward in the class as they were monitoring and motivating thirty students, all at once, at the same time. The actual experiences novice teachers worked to describe were of layered skills simultaneously active, or layered experiences. The researcher observed novice teachers delivering lessons and conveying concepts and checking for understanding, and also saw them simultaneously circulating through the room, redirecting students who were showing signs of distraction in a corner of the room with a teacher-face or gestured signals, and constantly tracking student responses. All of these different skills could be active at once, at times with very little conscious effort, at times with greater effort, such that facility in simultaneity became a sign of both levels and types of CL. Teachers in this study, when reconstructing this experience, identified this complexity each in their own unique ways, and at times would use analogies or stack different elements of the experience to communicate it.

When teachers were asked about their experience of CL, they used extended descriptions that stretched singular moments into multiple layers of thoughts and decisions, occurring all at once, and included perceptions of multiple happenings and mental responses. Their descriptions called to mind what Kagan (1990) called the "Goldilocks Principle." The magnitude of actual skills being brought into play in the classroom was too large to describe, or sometimes too small to perceive. Three bowls of porridge, three chairs and three beds may be judged too hot, too cold, too large, too small, too hard, too soft, or just right. For participants, the items actually came all at once and had to be judged simultaneously in every minute of teaching because the bears were always breaking through the door. One of the great tragedies in novice teacher reflective practice may be that their actual experience defies expression and that professional listeners may not have the conceptual framework to understand, or, more importantly, to accept what has actually been experienced.

Teachers experienced a great deal in the moment. Between what working memory can express in discourse and what teacher working memory was actually doing in the classroom, there was a gap. The experience of high CL could not be conveyed without crossing this gap, and teachers did so in two ways. First, through analogies like "juggling" or "navigating a map of forest fires" or the analogy of a "circle of vision," teachers conveyed the experience. As the researcher heard teachers create these analogies and others, it became obvious that analogy itself was a natural and necessary part of teachers grappling to express what they were actually doing. Second, teachers were heard crossing the gap through layered descriptions that pulled apart a single classroom moment into multiple individual thought processes. While such descriptions might seem to be multiple thoughts developed and separated in hindsight, the activity of describing might not have been post-reflective analysis (pulling apart) if the original thought processes were already in separate pieces to begin with, concurrently operating all at once or at the same time, as teachers themselves indicated. Teachers described processing multiple types of information always, performing and speaking and predicting even as they were tracking students, described the giving and taking in of information at the same time in order to accomplish immediate goals. As novice teachers would recall these moments during the interviews, they would seem to slip into the experience again, but in order to meet the goal of communication they would list the layers of questions and observations, names of students and responses they had eyes on, and delineate their pivots and moves, taking a minute to describe what actually occurred in seconds. Actual lived experience required such inventories in all teacher accounts. Just as teachers described how complex simultaneity pulled them apart, spread their selves, so teacher discourse was a process of pulling apart and spreading a moment of classroom experience.

Noticing is always an object in the working memory of the expert teacher and, based on teacher descriptions, could be classified as simultaneous and supportive of all other tasks of teaching. Teachers learning on their feet present a kind of learning unique to CTA, primarily because of noticing. Noticing preceded and accompanied and followed every classroom task which had goals to be evaluated, and different types of noticing happened during concurrent tasks. Sometimes teachers simply did not notice, or missed a great deal, and they defaulted to ignoring what was happening for the sake of more mental space or because the focus had become a particular process or skill that distracted them. But noticing was always present wherever ongoing classroom complexity, collective student activities and responses, was present, and these were always present in the classroom. Noticing is more than what CTA specialists might call a recurrent task, it is a pervasive practice. The working memory of the learning teacher will always be noticing, and noticing or tracking will always be at least one object or item within teacher working memory, an activity of receiving information from the entire classroom. As will be described later, the real classroom demands made learning difficult for some teachers, and mostly due to how much noticing was happening as new skills were introduced. It was a skill teachers aspired to perform simultaneously with every other skill, preceding and accompanying all learning and problem-solving decisions.

The researcher heard what novice teachers were reaching for with their mental effort, the kind of resources and performances their practice demanded. As indicated in descriptions, novice teachers sought to possess not only refined individual complex skills, but the kind of skills that could be simultaneously performed throughout a teaching day with other skills. They described a desire not only for automaticity in specific skills, but of simultaneity supported by the automation of individual skills. Keeping the classroom engaged and also noticing or tracking students were two goals pervading novice descriptions of their practice, what their mental effort strained toward ongoing. Engagement and noticing were described as operating simultaneously and continuously with most other techniques at all times. Noticing particularly maintained a constant place in working memory, both simultaneous to all steps of each skill and also the first step, locating a trigger, for most skills of teaching. No skill could be effectively performed without tracking student responses; tracking the specific response to a specific skill was performed simultaneously with other forms of tracking.

The way this complexity of simultaneity is articulated in traditional programs of teacher instruction may not represent the full cognitive reality. Teachers claimed they needed to be better at classroom management and behavioral and relationship skills in order to also (simultaneously) be better teachers. The performances associated with giving a lesson were “interrupted” by recurrent behavioral issues and the consequent grasping for mental resources to deal with these, a competition of conflicting skills in the moments of classroom teaching. But observations of expert teachers bear out that they are able to both manage behavior and perform complex tasks of instruction, eliciting student learning from students, analyzing student thinking and extending or correcting it, all while managing behaviors simultaneously (Blessing & Anderson, 1996; Ericsson & Kintsch, 1995; Feldon, 2007a; Gobet, 1998; Gobet & Simon, 1996, 1998; Masunaga & Horn, 2000). Listening to novice teachers, they attest to their capability as managers and givers of lessons, but indicate high levels of CL in the integration of the two broad sets of strategies and categories.

Participants described not only different complex skills to be acquired within teaching, but a different order of complexity, that of simultaneity of skills. The complexity of a single cognitive process and the complexity of simultaneity of processes, their concurrent performance, are in fact different. This complexity of simultaneity must be distinguished from the complexity within the individual processes, the steps of completing a skill or task within teaching. The complexity of a skill to be learned is not the complexity of skills that must be done concurrently. Working memory must contain the multiple steps of processes but novice teachers must also manage multiple processes simultaneous and concurrent with each other. In multistep complexity, goals are identified and steps taken in a specific task to meet specific goals. In multi-task complexity, different complex skills must be used simultaneously in order to make the one goal of learning occur, different performances are concurrently executed.

In dealing with this type of complexity, teachers expressed the need that their minds would form multiple bonds with the sources of information within the complex classroom. What is within the teacher in terms of skills and responses must form a mirror with what is outside, a mirror that is always being repaired and clarified. If there are several problems that arise and that a teacher should solve in the moment, simultaneous needs or responses, then the teacher's cognitive processes must be adequate to this environment. That is the learning novice teachers expressed a desire to achieve, and celebrated, that of automaticity of recurrent practices so that the nonrecurrent practices (daily lesson plan instruction, specific curriculum content that changes daily) could be performed. Novice teachers not only underwent this internal and external complexity, a complexity both in the classroom and in the working memory. They were hourly expected to *provide for* the events of mental and practical simultaneity. The unwritten but always evident goal underlying their classroom learning, learning on their feet, was to develop the skills and tactics to mirror and respond to this complex environment, and to do so on such a level as to *facilitate* simultaneity.

CL was described by novice teachers as both the result and the nemesis of this ongoing process of acquisition. Teachers associated types and levels of their CL with this complexity of simultaneous classroom events and the need for concurrent performances. Automaticity facilitated and supported simultaneity whenever teachers identified it in their own practice, and the awareness of automaticity impacted novice assessments of their ability in specific skills. While in CTA automaticity or the development of long-term memories is considered the goal, within teaching the ultimate goal is simultaneity, and automaticity of recurrent performances supports this goal. Teachers indicated that the recurrent performances as studied by them in preservice programs were not problematic in themselves, but that how these were executed in a classroom, a complexity characterized by constant simultaneity, mattered most.

Automaticity. When a skill or practice has become a developed schema in long-term memory, it is described as automatic. In CLT, automaticity refers to a level of CL which is minor, wherein very complex practices are handled in working memory as a single item. When a skill is not automatic, a teacher must think through individual steps of that skill in working memory. In interviews, it meant a performance that was so well practiced that it took little conscious effort; teachers reconstructing their lived experiences were able to identify and describe what it was like to experience automaticity in the moment. When something was automatic it could be done, teachers said, "without thinking" or without conscious effort. Teachers had no difficulty in identifying what was becoming automatic in their practice. They at times were dismissive of their automated practices, considered that their mental awareness might diminish when performances became automated, and knew the advantages of not having to think through their automated performances.

Textural synthesis. While novice teachers were still struggling toward mastery of skills, they could immediately identify decreased levels of mental workload in particular performances, and even dream of an expertise filled with automaticity. The researcher recounted items of teacher practice that were recurrent and seemed, from the outside observation, to be effortless and well-performed. However, while novices could identify these automatic performances and even celebrate their learning, they had trouble reconstructing what they did not have to think in order to do. Kevin Long described his becoming an expert.

> Interviewer: What will that be like when—you know you've mastered something that just keeps seeming to frustrate you now. How do you know that you're the expert? I mean, how will you know?

> Long: When younger teachers are coming to me for advice. I think that would be one way. Another is when I'm not having to worry about it anymore, when I'm not thinking of what I'm doing, when it just kind of comes naturally. And I don't even know if I would notice that, though. That's the hard thing . . . would I really know that I've got it down because it's just going to be naturally? Also, the results that I would see. The students engaged, and the students doing the work they're supposed to, and the kids enjoying coming to my class. Yeah, I think I would also see it in the students and their behavior. I think that would be another way I would see it.

Lack of awareness characterized automaticity for all novice teachers. They expressed a desire for it. It was as though the ultimate goal of their learning, when realized in performances in the moment, would make performances disappear from their minds. Long speculated that he might not know about the performance he no longer had to think about. He asked, "would I really know that I've got it down?" and his question indicated that something would happen to this skill or performance. The word "natural" was used synonymously with "automatic" in several different teacher descriptions. He used "natural" twice to describe the disappearance from thought of certain performances associated with mastery. Performances would simply happen, like an act of nature, "natural." Kevin Long also considered effectiveness as a sign of expertise in the following description:

> When I do something automatically, I don't know. I don't think I notice it happening so I'm not having to really think about it. When I do something automatically I think it tends to be effective. It worked. . . they've responded to what I asked them to do."

He seemed unsure, "I don't know . . . I don't think I notice . . . I think it tends." The act was unknown, unnoticed, and hypothetically tended to work. In most descriptions, automaticity was characterized as elusive, but not in the sense that it could not be attained, only in the sense that it would go unnoticed once attained, be something that could be done without thinking. Moreover, this lack of consciousness, in almost all descriptions, was expressly valued by novices.

Effectiveness or efficiency was a part of this description and others regarding what was automatic or in descriptions of higher mental effort. Efficiency is the ability to do things well, successfully and without waste. It is like effectiveness, except the latter is more about achieving a desired result. Teachers used both words to describe performances. In terms of simultaneity of noticing, Betz said of this growing skill and other skills, "But I think I'll feel more comfortable and confident quickly and efficiently addressing those two." "I think as time goes on, I'll get better at knowing what to do and quickly and efficiently doing it." Catherine Doe said of automaticity that it would allow her to "Solve issues more efficiently because right now I feel like I need to take the time to think about what to say." Kevin Long described his efficiency in terms of percentages, quantifying how doing multiple tasks lowered his "efficiency or effectiveness":

> I think that affects it as far as I'm doing all these things maybe at 75% of what I could be. Whereas, I could focus on something and have my full attention and my full energy into it but I feel like that kind of lowers my effectiveness across the board. I don't know if that makes sense. I'm thinking of here's all the tasks I'm doing but none of them are at 100% or the way I would like them to be done. So it's like, yeah, I'm doing all these things but it's kind of lowering that efficiency or effectiveness, I guess. Yeah.

Catherine Doe spoke of her technique of recognizing and remarking on positive behavior: "And so I think positive reinforcement was one thing that I've learned the most about. Being able to keep doing that because I've seen the most effectiveness doing positive reinforcement than anything else" and described how she determined "the most effective way to say it." Ella Finn spoke of how she was learning more effective transition techniques. Kevin Long's approach of "counting down" to regain classroom attention was evaluated by noticing: "Oh yeah, I think I do look to the kids and their response probably as far as, "Okay. That worked, didn't it?" It was effective." He said, "When I do something automatically I think it tends to be effective." Teachers in all of these examples had experiences of a spectrum of efficiency and effectiveness, they were aware of unwasted energy in these, that their resources brought to bear produced a positive effect. The researcher reflected that when performances were tried in the classroom and proved to be effective, teachers would utilize these repeatedly until these were automated. Effectiveness most likely preceded automaticity.

The ways novices described automated behaviors was commonly in a sudden relaxation, then in dismissive and bored tones, with brief struggles to recall what had been done; the lack of mental effort in life experience, it seemed, failed to produce stories and accounts and even memories of the steps of performances described. Novices repeatedly affirmed that when something becomes automated in their practice, they do not think about or even remember it. Novices could also sense fluctuations in mental effort in the middle of steps of a performance that had automated and effortful elements. In one final description of automaticity in his practice, Kevin Long gave an account of a shift from automaticity to greater mental effort in getting students to pay attention. The researcher helped him as he reconstructed a moment in class where he performed the technique he was implementing in the lesson observed.

> Interviewer: Yup. You said, "I want your voices off in three, two, one, zero." Some response. "Just listen up here," there was still some talk. "I'm waiting for you." Those were the three things you said. But you had a lot going on in your mind. I mean, you described the steps really well. How much of those steps do you actually remember doing?

Long: None of them. I mean, nothing other than—I don't remember looking at the class and saying, "Okay." Yeah, well, I think I only really remember—I think it's automatic up until I get to zero, and then at that point is where I'm having to think on my feet. So from that—

Interviewer: Because you're checking responses.

Long: Yeah. So, whatever those first two or three steps, whatever it was that I said up until I say zero, I feel like that's pretty automatic. And then once I get to zero, after I've said zero, from that point, I feel it's where I'm now having to think on my feet and respond based on how they're taking to it.

This passage is important because a teacher was describing an immediate fluctuation in his levels of mental effort, as though he was down-shifting gears in a car, from an automatic practice to a moment where he was noticing and preparing to respond to the unknown; he was also evaluating parts of a complex skill, identifying the efficient and deficient steps. His practice contained deliberate steps he was observed to perform, that he described as automated up to the point where he had to "think on my feet." It was the increased thinking that marked the change. He had trouble remembering up to the "zero" moment. It might be surmised that once he learned to respond to different student responses, or became familiar with multiple scripts and pivots, even this "zero" moment would disappear from his conscious thinking. Now, there was a moment when he had to "think on my feet and respond" to students that signaled the fluctuation. From that moment, he had to draw on other mental resources to respond, resources that were less immediate.

One practice that the researcher assumed most novice teachers had automated was attendance procedures. Ivan Jentz was prompted, based on the pre-second interview observation, to recall what he could about attendance, which had become automatic for him. The researcher first listed several very specific parts that he had actually observed, but Jentz resisted describing what he recalled.

> Interviewer: Tell me about attendance.
>
> Jentz: [pause]
>
> Interviewer: I mean, you started off—let me just remind you a little bit. You were connecting with the kids as they were walking in. It was kind of—it was what I call a nice, soft transition, welcoming them, asking how they're doing. I remember the girl right in front me. "Hey, where have you been?" And you just communicated a lot of compassion. And then you had them get their iPads out and their writing notebooks out. And they were going to get their books and they were doing different things and you were working on taking attendance. What was that like?
>
> Jentz: I try to get them to do something while I take attendance. Whether that was happening yesterday or not, I don't frankly remember. Maybe I was just asking them to be quiet while I did it. I don't recall. But I mean, that could be a—I think it's just what I use as just to kind of, all right everybody, count me down. Voices off. . . . And yeah, that's what attendance is. I mean, yeah, I have to take it and so yeah, I don't remember anything specific about yesterday.

He sounded, as he spoke, entirely bored with the question. His response was more of a dismissal of the automated task than a struggle to reconstruct it. It was important to him only because "I have to take it" and the rest was a "maybe I" and a "that could be" as he searched for elements he had become unused to searching for on his feet. His lack of memory, his inability to recall may be the ultimate sign of automation of this practice. He also fell back on presenting abstract strategies as his descriptions, possibly due to his unconscious activity; he remembered that he had certain goals that were a part of every attendance. The result of automation of recurrent skills might be that they are described by those who have mastered them with such abstraction, standing back from the actual moment experienced. Amanda Betz shared a similar problem with recalling her routine at the beginning of class, that is, that automatic, recurrent practices were difficult to remember, once they became part of her regular practice. However, notice that she began the following description by claiming she was better now at "remembering" the nonrecurrent elements of the routine, but completed her description by affirming she has "issues with recall" regarding recurrent elements of attendance.

> I feel like getting the class started and what I say to start class, I'm getting a lot better at remembering housekeeping things, like, "Hey, we're going to have a test next week. Conferences are on Friday so there's no school." So, I pretty much have those things logged into my brain that I know to say at the beginning of class every day. Same thing at the end of class, any last-minute reminders. And I constantly remind them about stuff that's on Google Classroom that they can get to. But, I don't know, I feel like maybe I'm having an issue of recalling things that I'm getting better at now because I don't think about them now.

Although she was "better at remembering" the nonrecurrent information she was giving, the communications that change every day, she had issues with "recalling things" she is "getting better at" doing, the recurrent elements, as those things do not occupy her thoughts at the beginning of class. She values what has been automated, what is clearly the habit or routine, although this habituation has made the recurrent happenings more elusive.

Catherine Doe reconstructed a transition she made with her students, as performed during her observation. Immediately before she mentally reached for and did this transition, she had discovered a huge mistake in the lesson; a problem in her teacher's edition did not match the student editions and produced sudden discord and chaos in her classroom, after which she transitioned students from the activity at their desks to an activity with students grouped on the carpet. The researcher noted, to her, that her performance seemed very smooth and efficient, with clear directions being given and the teacher's radar up. Outwardly, it was a very complex performance, at a point where students were riled up, with clear performance of multiple steps.

> Interviewer: When it comes to classroom management, you're different, you said? You do most things differently.
>
> Doe: Than last year, you mean?
>
> Interviewer: Yeah.
>
> Doe: When I was a student, [Name redacted], who's still my mentor teacher and my [direct] supervisor, she always was getting on me about transitions because they were never really clean. And I still don't think they're clean. When I did the book thing [transitioned to the problems of the lesson], I realized, "I don't want them at their desks. I want them at the carpet, so let's move [laughter]." I didn't think about what I would do differently. I just was like, "I don't want them there anymore. I want them to move. So, let's move [laughter]." Sometimes I think they understand that sometimes I'll change my mind, but I mean, transitions for me are not—I don't see them as the most important thing. I don't work on them usually. They are not something that I focus on, but sometimes I do if I notice they're taking too long. But in my mind they're not something that comes right away. I'm not thinking about it.

The key piece of this reconstruction of transitions was, “I didn’t think about what I would do differently.” That was what was different about her in terms of her ongoing learning of this recurrent practice. Her thought process was simple: she wanted it, she simply did it. As the account continued, she clarified what transitions had become, something less important, something she does not work on, or focus on. In her mind they were not “something that comes right away.” The actual performance of the transition, it appears, did not come right away into working memory, a set of consciously performed steps, as she was not thinking about it. The conversation continued:

Interviewer: You’re not thinking about it.

Doe: No.

Interviewer: When it happens?

Doe: Yeah.

Interviewer: Just—

Doe: Just kind of happens [laughter].

Interviewer: It just happens.

Doe: Just kind of happens.

Interviewer: Okay, so that’s one of those things. Would you call it automatic or accidental [laughter]?

Doe: I’m going to say a little bit of both [laughter].

Interviewer: A little bit of both. It feels that way, huh?

Doe: Yeah, a little bit. Sometimes I’m like, “Oh, I should do this,” and then I change it, or like, “Oh, I think maybe I’ll move them,” and then let’s do this. So I don’t know—

sometimes it's like, "Oh, I need to change my mind," and then it's an accident, but then sometimes I just don't think about it. I don't know.

Like Jentz, Doe seemed bored with the question, with describing her management of this transition. Effortlessness of a skill made for a slippery description. The researcher noted that her actual transition during the observed lesson seemed tight, well-communicated, with very obvious radar and tracking, the student pivot choreographed with visual and verbal signals from the teacher. But her account of this, her reconstruction of it, was utterly casual and even dismissive. Novice teachers, while extremely detailed when describing overload, times of high CL, and the points where they reached mental limits, were often unable to describe what was automatic, even though what had become automatic, what they had mastered, was performed with clear and effective steps. Doe did not (or could not?) see herself as she actually had done the transition. It seemed like she was describing an accident to the researcher, something done without thought, so the researcher had asked her, and she confirmed it might have been. She only remembered she did it, that the skill "Just kind of happens." When other novice teachers were queried about their more smooth and recurrent practices, their descriptions also slipped around them, as though they had never really appeared on their radar screens, even though some of these were their most refined performances. Teachers even seemed to question the reason for discussing these skills, since they had become unimportant in their learning to become teachers. Later in the interview, Doe briefly distinguished automaticity from a higher load in the same way. Her laughter during the exchange was a nervous laugh over the simplicity and finality of her own answer.

Interviewer: When I do something automatically, I . . . ?

Doe: Don't have to think about it.

Interviewer: Okay.

Doe: Okay [laughter].

Interviewer: "[You] don't have to think about it. . . ." When I do the thing I'm still working on, I. . . ?

Doe: Have to take longer to think about it. What I need to do, and how it's going to work. I play it out in my head, usually.

Interviewer: Okay. As you're up there in the middle of it?

Doe: Mm-hmm.

Doe measured her mental effort by an amount of thinking she had to go through, a thinking that might "take longer," that involved goal identification and steps ("what I need to do, how it's going to work") and even a mental rehearsal. But the automatic was immediately available, it happened without her even trying to grasp for it. How did her performance happen without her thinking about it? She decided and it "just kind of happens." It was a performance that seemingly activated itself, without her effort. The automated skill happened, and it was the activator; when she had higher load, she was the active party, as she had to think, needed to do, and she played it out mentally before playing it out in the classroom. As indicated in the literature review, experts often struggle to report on their recurrent, habitual practice, due to the fact that much of it is not conscious. Novices were also subject to a *laisse fair* dismissal of such practices during recall.

As described in the prior section, Amanda Betz explored her growing automaticity mostly around the skill of noticing. She associated automaticity with the performance of simultaneous tasks. It was her concurrent performances that made her conscious of her own automation of skills, and as two skills operated at once, she could see the differences between them.

> Betz: This person always faces me and today they're hunkered down trying to sneakily text, or they're on their laptop, or they're heatedly whispering to their neighbor. There are those physical tells that I feel I'm getting better at picking up on.
>
> Interviewer: You're noticing more.
>
> Betz: Yeah, which hopefully will become just automatic and I'll know it instantly. I mean, I feel like some teachers can tell by how they walk in the door if it's going to be a good day or not. And I'm not there yet [laughter].

She described herself, "I'll know it instantly" and associated this with growing automaticity in noticing. Some teachers knew it would be a good day or not by noticing how students were coming through the door, an instant knowledge. Betz was not there yet, but she had already been initiated and saw a glimmer of her own expertise:

> When I do something automatically, I don't think I think about it, so it's probably hard for me to reflect on it. But there are definitely things that I started doing that I don't think I think about as much. Like when I bend down and talk to someone, I do feel like it's automatic for me, and I hope the student doesn't think it's rude. And that's what I also worry about in my head, "I hope [Name redacted] doesn't think I'm ignoring him because I really am listening with my left ear. I'm just using my right ear and my eyeballs to look around." So that's what comes to mind the most when I think of automatic. I'm just always scanning the room with my eyes.

Here the theme of not thinking about what one was doing when the skill was automatic emerged again. It was difficult for her to reflect on it. She gave this convolution of memory: she does things that she does not think she thinks about. One may anticipate that, when asked for descriptions of automatic skills, novices will find these difficult to reflect on and reconstruct, an element of expertise scientifically demonstrated in CTA, As Betz said, *she definitely has started doing things that she does not think she thinks about as much*. Helping a student one-on-one was automatic and was identified as such with reference to the simultaneous skill of noticing. However, at the end of the second interview, in reference to her attention being split from an individual student to at the same time tracking the entire class, Betz compared the complexity of her different classes and said of noticing: “I wouldn’t call it automatic, but I don’t think that I get bumped out of the flow as much as with that class.” It was a powerful description for the researcher. She was describing a skill based on the level of mental effort it took, as experienced in the moment, in a specific period of the day. She had spent an hour reconstructing experiences and describing mental effort, and in these final moments had encapsulated a very subtle description of load levels in her own words. What were the elements? Her skill level was being described both in reference to her classroom’s challenge, and as not “getting bumped out of the flow so much” in reference to how steady it was, its low levels of fluctuation. This description could also be a good type description for germane mental effort, a higher level of learning load was experienced (it was not automatic) which did not “bump” her out of the flow (it was just not high enough). She sounded like Kagan’s (1990) Goldilocks: “This one is too hard, this one is too soft, this one is just right.” If she sounded like Goldilocks here, it may be because she had overcome the Goldilocks Principle, Kagan’s principle that teacher cognitive processes were too large or too small to describe. She also described an experience of being overwhelmed by certain situations, but concluded with a hopeful description, “And I’m hoping that, eventually, I’ll be able to just kind of not stress about it as much and just do it. . . . but right now, I don’t have cruise control yet. I’m still on the pedal. I’m still watching for all the obstacles. I don’t have cruise control yet.” The analogy of driving a car was a learning analogy based on mental effort, where the driver met complex problems, but was still in control, not in cruise control (automatic), but with her foot on the pedal, in control of her effort (germane load). The effort was still there, but she was in control of the accelerator. Betz elaborated on this hope she had for automaticity later, in describing how she would "get better":

> Yeah. I notice more. I feel like I could get better at that. Interruptions, I feel like, eventually, I'll get better at dealing with (interruptions] whether. . . with proximity or some kind of thing I say to them like, "Hey, first warning," or some kind of phrase that they know that I can just kind of spit out that my head, will automatically say. Like, "Hey, [Name redacted], that's *one*," or I don't know, whatever I end up saying. Maybe something like that could become more automatic and flowy.

These were recurrent elements of her practice. The automatic phrase to redirect students here was "kind of spit out of my head," both a physical and cognitive ("will automatically say") description. She continued, describing effectiveness as Kevin Long did, that the effectiveness of the recurrent practice would be a sign it was automatic:

> And the kids will know that too. They'll be used to me saying something like that, so they'll know to change and correct their behavior or whatever path they're on. I mean I feel I'm like that with attendance. . . . I feel like that's something that flows, and I always have the warm-up on there. So mentally, even when it is my prep period or before, if it's the last five minutes of me helping kids or if it's my prep, I just automatically know like, "Oh, I need to go get my laptop and put up the projector and warm-up." And I know that as soon as kids come in, I need to do the role. I don't say it out loud. I just look around, do it. And I very, very rarely forget to do that nowadays. So maybe that is not something

> super important, but that's something that's been easier to automatically get in the hang of.

Again, in her last line, the novice teacher had automated her attendance and it had become "not something super-important" and strung three descriptors together as something "easier to automatically get in the hang of." In this description of her effectiveness, it was hard to tell if she was describing classroom flow or her own flow, or if it even mattered at this point for her to distinguish. "I just automatically know" she described. The steps of saying it out loud and looking around just happened. She further envisioned what that kind of automaticity in doing attendance would allow her to do, and offers here a description of mental space characterized by increased performances becoming available:

> Focus on other things. Notice other things. I feel like at the beginning of the year when I was still trying to get to know their faces and their names and I had to call their name out loud and slowly go through it, there were other things going on that I couldn't pay attention to that maybe I should have picked up on or conversations that I hear that I should probably tell the counselor about or whatever. I feel like I can pick up on more of those cues because I know what I'm doing. I know the program now that I take attendance on. I know my kids. I know their faces. I know where they sit because they have a seating chart. So I'm really doing that automatically while listening. Who is just putting off the warm-up? Who is actually doing the warm-up? Who hasn't even gotten out their notebook yet? Who am I going to have to ask about missing the test last week? All those other things can go through my head instead of, okay, how do I pull up the role roster? There's more room for other stuff that is more important.

There were powerful textures in this description. She fluently moved from the importance of splitting her attention to an affirmation of what she knew, the knowledge that allowed this split attention (e.g., "I know this, I know that") and then a list of awareness questions jumped to her mind as she was listening to and noticing the class. This last portion was powerful, in that she took her automatic questions and gave them layers, and did it without pause for reflection, for, as she spoke, the list of questions just came forward. In class, all the questions were in her mind at once, but her description isolated each. Amanda Betz was gifted, especially in this moment, with a startling introspection. She very naturally slipped into descriptions, in her own words, of her mental effort, and was able to attach it to skills and shifting demands in her classes. In her last sentences she even described how she would be able to have "more room" in her mental process once "pulling up the role roster" was automated. She will have "more room" for "other stuff."

While Catherine Doe had a problem with calling herself or anyone else an "expert" or even believing in expert teaching, she described how she would know she was an experienced teacher: "When I don't have to think about how to react to all of the situations. Now I know the kids enough in this class where I can say I'm experienced with this group of kids but not with all the scenarios that might happen." She affirmed many times in our interviews that her knowledge of students, her personal relationships with them, had priority. She paid attention to what was unique in every student. But she also affirmed here that she desired an automaticity that would allow her to react to situations without thinking. Because of her passion for personal relationships, she aspired to handle social conflicts between students in better ways, as these arose in class, saying that if she could automate those skills she could then

> Solve issues more efficiently. Because right now I feel like I need to take the time to think about what to say. Sometimes I'll actually go to [Name redacted, an experienced

> teacher] and ask her what to do. I'll say, "This is what the situation is, how would you react to it?" Because she's been doing this for so long. Sometimes I have to take time to think about what I need to do, where she can just handle it. She's good at social issues with kids. That's the one thing they don't teach us, is how to handle student-to-student problems.

Efficiency of solutions, that the effective solution to a problem would appear, she would "solve" it, was her leading statement. If mental effort was focused on finding solutions, lack of mental effort means effective solutions are there, immediate. Needing "time to think" characterized high CL in several descriptions. Instantaneous responses characterized automaticity. Right now, however, at her current level of learning, she had to "take the time to think" and this characterized high CL in several descriptions. Novices often described expertise in terms of automatic responses to problems, or noticing things instantly, that experts would "just handle it." Ella Finn discussed how much she appreciated an expert teacher in terms of how she managed classrooms; when she was more like that teacher, she would "manage my own mind enough to think through [classroom management] in nanoseconds on how that's going to go." Time to think was a measure of mental effort, and having thought happen in a split-second, in nanoseconds, was a sign of expertise. This was a result, for her, of a mental management, though it is unsure if it is a management of space or activity or a combination of both; when her cognitive process was "enough" she could do it. Instant knowledge, doing without an interval of thinking, having a response in nanoseconds characterized descriptions. The mental resource was immediately available.

Automated skills are immediately available to the point that performances just happen. Teachers who were also mothers described how they would often revert to skills they had developed as mothers, even in the classroom, going to what was automatic for them, even though the practice might not be as effective. They did what was immediate and what was available. Ella Finn spoke of an expert teacher she admired and wanted to learn classroom management from:

> Because she has incredible skills that she's developed over her years in teaching. . . . She knows the reaction that's going to get her the results. And so, sometimes, I'm not great at that piece. I have 23 years of being the mother to my children, and so my reaction might be how I would manage my children, but not necessarily the reaction that's going to get me my goal with that child.

Ella was claiming to revert to what was "natural," the automatic response she would have as a mother, although she recognized that such skills might not be as effective in the classroom. Gina Hunt, also a mother, linked the term "natural" with "automated" in describing the tools or techniques she reached for in trying to solve recurrent problems. As a mother, she had certain "natural" responses built into her memory that were automated, that she could turn to immediately. As her mental effort increased, and clarity disappeared, she was unable to reach for the right tool and instead would "lean on what's natural," the learned and automated "mother's" response:

> Hunt: So throughout that 30 minutes that you [the researcher] were observing, or 40 minutes, I would say that level of clarity was decreasing because the more things that were getting thrown into the mix, the less likely it feels like you are to be able to reach and use a tool that you're trying to use because you just lean on what's natural.
>
> Interviewer: Okay. Natural as in just kind of—
>
> Hunt: Automated.
>
> Interviewer: —what you already know?
>
> Hunt: What you already know. Your automated responses will start to take over because that's just how you're going to function.

Interviewer: And it may not be logical or loving, as you said earlier.

Hunt: More mother-like.

Interviewer: It's more mother-like?

Hunt: Mm-hmm.

Interviewer: Like, snappy [laughter]?

Hunt: Yeah. Go to your room.

Again, there was a reference to reaching for a tool or resource, that it became less likely one would find it as mental workload increased and clarity disappeared. In this situation, the teacher did not merely fall back on what was automatic, the automated responses actually "take over." The automatic took action, took control. In this case, it was the less efficient resource or performance, but it was "just how you're going to function." Teachers experiencing high load leaned on the automatic response; it might not have been the right response, but they sometimes took whatever was most available as automatic even though they recognized that a skill that had not been automated yet might have been a better choice. The automatic simply presented itself. The "mother" skill habituation came forward many times when Hunt described how, during higher levels of mental effort, she would reach into that immediately available skillset; she also described her ongoing conflict with this, what cognitive psychologists might call a default, a reversion to the automatic.

> Well, sometimes, and I think I'm a novice teacher that's also a mother, so I have high expectations of behavior, and sometimes my approaches are more mother-like versus teacher-like. And so a mama bear will nip at her cubs. A teacher is not supposed to nip at their students. So focusing on being positively redirecting instead of just, "Stop doing

that," you know? Or just those real short, sharp phrases. So it takes a lot of intentionality for me to stay in my teacher voice instead of my mom voice.

In practicing and implementing new skills, sometimes a teacher resisted what was automatic, what simply comes and takes over. The researcher can assume that all teachers have a natural response in class, not just the mothers, and that this comes automatically to the surface unless the teacher applies mental effort to a new cognitive process, a new resource or performance. The strategy Hunt described here was "intentionality" to stay in the "teacher voice." Lemov (2015) describes many different types of teacher voice, from "Warm/Strict" to the "Strong Voice" techniques, and how experts have been observed to utilize these voices. Hunt realized she needed her more effective "teacher voice." If this was the case, why did teachers default to the automatic? It could be to reduce the level of load immediately being experienced, or because that was the largest tool presenting itself, or both. She seemed to be describing skills that simply activated. Hunt described automatically reverting to her motherhood skills in reference to an unexpected earthquake drill that happened during the pre-second interview observation; this lengthy exchange is offered because it captured not only the reversion to the automatic, but the delight at having found something effortless and slipped into it automatically. The observed lesson suddenly stopped, students became very excited as the drill began, and the teacher very smoothly maintained order and coached the students under their desks and throughout the drill, keeping a level, formal tone. The researcher had seen what he interpreted as a nervous smile during the drill, and assumed that this sudden disruption had caused an increase in CL and predicted it might lead to a description of cognitive overload. The following, surprising exchange began with a request that Hunt subjectively report her CL on a Likert scale of 1 to 10:

Interviewer: Earthquake Drill, on a scale of 1 to 10?

Hunt: That I loved.

Interviewer: You loved that?

Hunt: Yeah. I'd say a one (1).

Interviewer: [pause] Because—?

Hunt: That kind of stuck to me.

Interviewer: Why would you say that? That was in the middle of your lesson and—

Hunt: I loved it. Because it was something that had to happen, it was physical, the kids loved it [laughter], and it was almost like it goes back to that mother-teacher thing. It was extremely easy to nurture that. It made sense. It was about safety. It has really nothing to do with teaching. It almost felt like a break.

Interviewer: They've also practiced it, right?

Hunt: Once.

Interviewer: Once?

Hunt: Yeah.

Interviewer: Okay. Wow.

Hunt: Once this year, maybe. So yeah. To me, I was like, "I would stop any lesson at any point in any day to have an earthquake drill."

Interviewer: That one [subjective report of CL] I felt would be more, I think.

Hunt: No.

Interviewer: You were smiling the whole time. It was like you were smiling—

Hunt: Right. I was happy.

Interviewer: You were happy. I thought it was a nervous smile. Oh, my gosh—

Hunt: No. I was laughing because I was so glad you were here. I was like, "Oh, this is such a good thing to have earthquake drills!" [laughter]

Interviewer: Okay. I misread that totally. I did. Wow. Okay. You were happy. You were really happy.

Hunt: That's the one.

This account could be categorized as a "happy" reversion to the automatic. Her level of mental effort completely disappeared. There were more tragic reversions to the automatic that entered into accounts, where teachers facing complex problems in the classroom would reach for a solution and find the toolbox empty, and offer natural or, as Hunt indicated earlier, "snappy" responses. Classroom management "strategies" had been given to all teachers in their formal education and in their coaching sessions, but this learning was often described as information received and put aside, not built up as techniques within long-term memory schemas through isolation and drill. Teachers would sometimes default to a "natural" reaction, whatever first came to mind, which was not often effective. They expressed that they wanted something more, reached for it, but went with what they knew. Several accounts of these instances or reaching and finding nothing will be given in the "Overload" section below.

Structural synthesis. It seemed ironic for the researcher that what one's wonder might attach to the most, the effortless and instant and impossible-seeming flashes of automatic skill, the performances done simultaneously with other performances, were also the techniques that were so slippery to talk about, and the most dismissed. What had seemingly received the most attention and was mastered was also the performance ignored the fastest, as teachers grew and acquired learning. The most recurrent elements of teaching were mastered the fastest, and then simply disappeared into the teacher's flow, often beyond reflection. However, when teachers were asked to think about their levels of effort, they were also able to celebrate the moments of effortless skill.

This research followed where novices went in their descriptions of mental effort. A surprising reversal of this was that when novices described mastery of skills, they went to a performance requiring minimal mental effort. Repeatedly, novices spoke of "not having to think" of their most efficient performances as indicating mastery. This is the goal of learning in CLT, that mental effort may be lowered and space in working memory may be created through the automation of skills. Novices were able to identify this space, a pushing back of limits, due to the automation or habituation of certain skills.

Automaticity was described in terms of immediacy and availability of performances; at times, this was a "mother's" or a "natural" response, a reversion to something outside of specific learnings associated with teaching. Teachers recognized it was outside of learning, but the immediacy and availability of the response was what made it present. When a tool was out of reach or not immediately available in the moment, the natural or automatic response activated. If mental effort is characterized as grasping for resources and steps of performances that will bring about effective, positive results, the lack of effort may be signified by the performance simply presenting itself, as teachers described. In later descriptions of levels of load, teachers will lament that much of what they know about teaching had been given us information, and that this immediacy and availability is lacking at moments of high CL. The "tool bag" must be rummaged through in the moment. The performances that were automatic simply happened, and happened alongside other concurrent performances.

Novices indicated a lack of consciousness, a lack of intentionality and focus, in doing the automatic. As indicated in the literature review, experts often struggle to report the parts and steps to their recurrent, habitual practice, due to the fact that much of it is not conscious. The fact that the most recurrent elements of practice may become the most automatic, and due to this will be harder to describe, that what composes expertise may remain most elusive, is problematic to learning design. Because of the environmental and learning demands, novices who mastered certain things such as attendance said their focus shifted immediately to other things. But the researcher who observed novices enacting multiple steps in skills also found that novices struggled to remember the steps and parts of these skills once automated. As CL theorists indicate, complex processes seemed to have been "chunked" and made one thing. Novices were subject to a *laisse fair* dismissal of such practices during recall; these skills were no longer "super-important" and novices questioned their own ability to think about what they no longer needed to think about doing. This inability to describe what is most known, most learned, is predictable.

In the working memory, the steps of complex skill do not need to occupy mental effort. Some of the best performances of novices were executed without doing so. When a skill is being introduced, not only the steps of a skill must occupy the novice teacher's mind, but multiple steps of multiple complex skills must be executed simultaneously, such that without the automation of those skills, teachers will be ineffective. Only with greater automation of multi-step complex tasks will simultaneity of tasks become possible in the limited economy of working memory. Teachers indicated that automaticity served their simultaneity of performances, and did this in both this section and the prior section.

Cognitive overload. Novice teacher participants gave rich descriptions of moments of overload. Overload occurred in unique and singular moments, and textural descriptions gave multiple contexts, including high levels of classroom distractions. It involved moments when performances could not meet demands, or when teachers reached or searched for resources and performances in themselves and found nothing to help, or unclear processes. Defects in learning, where novice teachers did not have the tools to meet problems, or were missing steps to complex processes, could also cause a shutdown. One of the teachers struggled with engaging a class, for example, and the researcher asked the teacher to describe the attempted skill's steps subsequently, and these were entirely unclear. Teachers often struggled to name the steps of isolated techniques, and described general strategies instead. It should also be noted that, in terms of defects, most novice teachers struggled with taxonomy, and even questioned that the techniques of teaching had been given names: several were perplexed at being asked to provide formal descriptions of the steps in skills. Defects in learning, where novice teachers did not have clear solutions to meet problems, or were missing steps to complex processes, were also powerfully revealed. Defects emerged that could have been based on beliefs, learning culture or learning design. While it is not the purpose of this study to evaluate the participants as teachers, defects in learning design as they emerged from teachers are a relevant factor in the levels and types of mental effort teachers undergo.

Textural synthesis**.** Amanda Betz described her experience of being "on overload" regarding how to solve a problem that the researcher chose to de-identify. While feelings accompanied her problem-solving experience, the source of her being overwhelmed was not emotional frustration, but "not knowing what to do."

> Betz: Anyway, I've been having a lot of issues arise with [Name redacted], and it's all brand new and I have no idea what to do. I feel constantly on overload with [Name redacted] because of all these things. . . . But I don't know what to do. I still don't know right now. And just all these things stacking up, and I don't know what to do. And still don't. And it seems like no one else does either. I've reached out to the counselors and

other teachers, and everyone's having the same exact issues. So, I think I feel more over-loaded when I know I can't reach out for help. . . .

Interviewer: And you have everything else going on while that's going on.

Betz: Yeah.

Interviewer: Okay. And what's that like for you when—?

Betz: Oh man. Physically? My heart beats really fast, and I feel like—honestly some-times, when I'm really frustrated, my voice starts to shake, and I know that, and then I get self-conscious about that. . . . I don't know.

"Not knowing what to do," as other things were stacking up, many things happening at once in the classroom equated to many cognitive processes demanded of the mind. The learner simply did not have the steps of a problem-solving process available, and no "natural" or automated re-sponses were available. Betz's mind was working, searching, and she was overloaded by the search, almost as though she was spinning. In her account, as Betz searched for answers for working with the difficult student, she herself seemed to increase her load. Her awareness was heightened, and she began to think faster. She gave a layered description of those moments:

Betz: I'm constantly aware of my facial expressions, and my body language, and my tone of voice, and how loud I am, and if I'm crouching down or not. I'm constantly ana-lyzing. So I'm trying to be very conscientious about how I'm presenting myself. . . .

Interviewer: Okay. I'm interested in this. I've seen kind of—

Betz: No. [It's nothing?]—

Interviewer: I'm really interested because your description is very unique. You've got this space in your memory that's at the front of your brain, and when it starts to fill up, you shove even more in there [laughter].

Betz: Get on in there [laughter]! But during class, I really do feel comfortable, and I have not had very many times that I felt overloaded while teaching.

Interviewer: But today wasn't those [crosstalk].

Betz: But today, with [Name redacted], [I] was not in the teaching—and even though I knew "I'm losing them, they're losing interest," I didn't feel overloaded. I knew that I would have to confer with another teacher later, chat about it, get some tools, try them out tomorrow. But with that situation, I don't know what to do. I feel helpless because I've exhausted all the resources that I'm aware of. . . . I've checked all the boxes literally and figuratively, so I feel overwhelmed.

In an anecdote below, she associated being overloaded with "blanking out," and she had not reached that point in the above anecdote. But she was on the edge here, no longer "in the teaching" and had "exhausted all the resources." What was striking in this initial description was how the participant moved from a moment requiring powerful mental effort into elements of learning. While this was a description of an emotional moment, with feelings of helplessness, Betz was the one contextualizing the moment of overload with her own learning, her need to search for a mentor, a tool, a new plan. "She does not know what to do" was the constant refrain. She had checked all the boxes and still had nothing in terms of a solution to the problem. She blamed being overwhelmed on the amount of knowledge she had and had made her teaching a quest for answers. She was reaching for a tool or technique, an adequate response to the challenge offered the situation, in the moment, and she found nothing there, her hand came back empty. The impact of some very high levels of CL was repeatedly described, in her own language, as "blanking out", an inability to "think on the fly":

Interviewer: Okay. So you said you encountered too much information with [Name redacted]. . . . Were there other places where there was too much?

Betz: Not today. I do feel like that happens. Sometimes when kids ask unexpected questions, and we talked about that in the last interview, if I honestly can't think on the fly and figure it out, I feel guilty and bad. . . .

Interviewer: How do you know when you have too much information to think about?

Betz: I feel like I blank out. I mean, not pass out or anything, but I'll definitely draw blank and feel like physically—I don't blush or anything, but I think what's going through my head is like, "I don't know the answer, so I'm going to have to look silly right now. . . ." And I do feel like I'm getting better at that. I don't feel overwhelmed very often now. I did in the beginning of the year, just because there were a bunch of random questions that I didn't foresee happening and I was constantly thinking on my feet.

She was constantly thinking on her feet when overloaded, but in spite of this heightened activity the answers were not there. While she insisted, self-consciously, that she was not overwhelmed very often, there were characteristics of a mental process that shut her down as she pushed her mind for responses and answers and solutions to problems. She drew a "blank" but it was not from a lack of activity or struggle, an empty place in her mind. She was having to "think on the fly" as in her earlier teaching when she "was constantly thinking on my feet" and what she wanted was not there. Not having the appropriate response had not left this teacher in a passive state, but in a state of overload, where she was "bogged down." This account was her own summary of her dynamic overload:

Interviewer: Tell me about hitting the limit.

Betz: I feel like hitting the limit is when I can't—I don't know. Like mentally exhausted and can't remember what I'm supposed to. I mean, I don't know if maybe when I blank out is a mental limit because I'm trying to do all these things simultaneously and teach at the same time, and it's just like "Whoa, too many things at once!" But as far as overloading and hitting the limit, like I can't cram any more information in there, it happens.

The other pieces of this account have led up to this powerful, rich description. She described her initial "I can't," located it in memory, said her "blank out" might not be a "mental limit" because so much was happening "simultaneously" (her word!) while teaching. Finally, without evoking the technical term, she cannot "cram any more. . . in there" where the "there" must be a mental space. Her overload was a phenomenon of learning. It described a search, a reaching out, and a mental space which was not empty, but full of straining for information that could no longer fill a crammed space.

Catherine Doe described several moments when she had to process too much. She reconstructed a point in her lesson when she simply had stopped, her attention divided between an individual student and a group in the circle around her and the students spread through the classroom. On the outside, she appeared immobile to the researcher, but what was going on inside, according to her later description, was not. At the end of her description, she moved from her own words to adopt the construct that had been briefly introduced to her.

Interviewer: So, what was that like though? I mean, could you give me more of when you reach those points where you have to process too much? Just more of a description of—you've given me a lot already, but—

Doe: I feel like that's what I look like in class when I think.

Interviewer: Do what?

Doe: That's what I look like in class when I think [laughter]. Sometimes when there's too much, I feel like I'm not doing what I should be doing. I wonder, "Why is there too much? Should I be changing something because there's too much to handle right now?"

Interviewer: Changing something?

Doe: That I'm doing or the class is doing. I don't know. Sometimes I think if it's too high of a cognitive load, maybe I need to be changing something to lower it. But sometimes I don't know what.

"That's what I look like when I think" was Doe drawing the researcher in from external observation. Things were not what they appeared to be. She was saying "*That* moment I stopped is what I look like when my mental process is *really going*." Doe was not stopped, as she appeared on the outside, but her immobility was what she looked like when she was thinking. When so much thinking was happening, it led her to the question "Why is there too much?" and the really relevant question of whether something should change, whether a new practice could lower the "cognitive load." Again, a teacher was reaching for something that would lower the mental workload. Ella Finn described similar moments when she was "spinning" due to too much information to process:

Finn: There's maybe the stress of feeling like I'm spinning, like I'm not really gaining and I'm not really assimilating that information.

Interviewer: You're spinning?

Finn: Spinning. . . . Yeah. I like that term. It's like you're just kind of spinning. It's like [inaudible], pivoting around and not really accomplishing anything.

Interviewer: Yeah, we're back in the river. The raft is [laughter]—

Finn: I'm telling you, it's all very—

Interviewer: Life is a river [laughter].

Finn: It pretty much is. I can make an analogy for anything in a river. But, yeah. Just spinning around, just one oar, just going around in a circle, not making any headway.

Sometimes I eddy out. I can't get out of the eddy, can't go down-river [laughter]. Yeah.

Spinning refered to turning and going nowhere, not reaching the accomplishment, and the description was given in the context of "not assimilating that information" or learning. There was awareness here of a direction, a next step that needed to be taken, but even while paddling, there was no headway. Overload was like being stuck in an eddy, "eddy[ing] out." When Amanda Betz "blanked out" it was a moment of heightened mental activity as well, and one of searching for techniques.

Sometimes it was difficult to decide if being overwhelmed was due to cognitive overload associated with learning theory, or that a teacher shut down due to emotions such as frustration. Did teachers offer descriptions that would allow one to distinguish stress or frustration from the mental effort learning designers associate with learning and problem-solving? For example, when asked how her learning as a teacher was impacted by her classroom's complexity, Catherine Doe said,

> I guess, thinking about yesterday, some of the kids wouldn't stop talking and I always think about, "Well, this has worked in the past, I should try to do this." But then if it's just not working I get really frustrated. And then I just kind of shutdown, and then I ask the kids, "Just—please, stop." Sometimes I'm not able to learn if the kids aren't responding or if I no longer have the patience for it.

It is hard to tell if this was emotions canceling thought or cognitive overload. Cognitive overload was described with simultaneous complexity, with the mind having too much, processing too much. A teacher's emotions however might stop thinking as well. Emotions could affect a shutdown, or cause a teacher to draw a blank, or, instead, emotions might result from overload. In the account above, Betz had chosen something that worked in the past, but it did not work. She became "really frustrated" and then she shut down. However, at the end, her shut down was a shutdown of learning, "I'm not able to learn" when the students do not respond. This is a hazard of learning in the classroom. This was a problem of learning design. In the following account of overload, the emotion of frustration plays no part, and Doe does not mention emotions at all:

> Interviewer: How do you know that you have too much to think about?
>
> Doe: When I can't talk.
>
> Interviewer: When you can't talk?
>
> Doe: I just stop and think. Sometimes the students will come up to me and ask me all these questions, and I can't answer because I just don't have an answer. So I need time to think. With that, I had to sit and think for a second and say, "What am I going to say?" Sometimes I get to the point where words won't come out [laughter].
>
> Interviewer: Words won't come out?
>
> Doe: Yeah.
>
> Interviewer: Okay. That's always your signal—?
>
> Doe: I know I'm too overwhelmed when I can't speak. Or sometimes, I'll try and talk and words will come out weird. My words will be muddled, and I'll say, "Hold on. Give me a second [laughter]," because I've got to get my words together.
>
> Interviewer: Is it a strategy of just stopping talking, or do you feel forced?

> Doe: I wouldn't say forced because I'll try and talk and it won't come out the way I like it, or something will be weird, or some— I don't know. I have to take the moment to sit and think, "What am I going to say?" Because I don't feel like I have—I can't react to everything in a way . . . and so when I'm overwhelmed, I just—it's probably a strategy, and also, I feel like I have to do it [sit and think] because if I don't, I can't do anything.

She must stop talking when overwhelmed, according to her. But this description included no emotions one might associate with overload, only a renewed and more focused management of thinking when she reached a point of thinking too much. She was not forced to quit talking, but her talking and thinking at the same time seemed to produce a conflict and she had to do one or the other. It appeared to be an issue of too much mental activity, of a performance of thinking with the performance of talking not fitting in the same space at the same time, in the moment. However, is it possible that an emotion can simply interrupt the working memory? That a strong emotion can have such magnitude that it makes thinking impossible? It is an important question for those who design learning and consider heightened CL; a teacher might not need a more automated technique but instead need to deal with emotional issues. In Catherine Doe's case, it was about her thinking. Ella Finn presented a dramatic contrast in the following account that seemed to highlight the difference between emotional and cognitive overload. While Ella Finn began speaking explicitly about CL as a construct, in the middle of her account she switched suddenly to her emotional response to student disrespect.

> Interviewer: And then we have this working memory that's at the front and holds about four or five things. Do you experience that? Do you sometimes just—?
>
> Finn: So my working memory holding four or five things you mean? Is that—?
>
> Interviewer: Mine only holds two.

> Finn: I don't know how many mine [laughter] holds. Not very many. Actually, my mentor thing—we did the thing in working memory [in a session about student CL] and I think mine held five numbers, or something. And then once you got past the five numbers of doing something with them, I was like, "I can't do that, do anymore." And if you go to letters and backward spelling, then I'm down to three. So, it really depends on what you're talking about but—I mean, I don't know. I don't know the answer to that. I feel like I can probably hold four, five things, and then I have to say, "You need to sit down. I'm going to deal with that in a minute. Let me take care of these things first." So, I can't juggle that fourth or fifth thing. I think one of my limitations is my frustration that I have with students being disrespectful. I have a real frustration with that. And so sometimes I have to drop everything and stop everything and deal with that, and that is probably my biggest irritation. But other than that—
>
> Interviewer: You care about that student, you want to solve that problem.
>
> Finn: Well, usually if that happens, it's really more than one student. There's three or four that have lost all self-control and just are being disrespectful. . . . If that's going on, there's no working memory. We completely stop, and then I have to get back on track.

There was a sudden textural change in this account, from a lesson on student CL where Ella was introduced to the idea of working memory and how she associated that to her learning, to a description of frustration and annoyance at student disrespect, which stops everything. "There is no working memory." She did not describe herself as having attention split, thinking too much, or reaching for a technique or trying to perform a process that had become overwhelming, but instead described changing her goal, going in another direction, due to the intolerability of disrespect. Her emotion presented a different kind of mental limit, the frustration and irritation completely erased other goals and she stopped her class. Powerful emotions can interrupt memory, but such interruptions have a different character than those caused by multiple cognitive processes during learning. It should be noted that although teachers described an awareness of powerful emotions, most descriptions of mental effort utilized terms of cognitive processes, learning and problem-solving performances.

Overload presented problems with dialogue. Prereflective lived experiences of what it was like to be overwhelmed with mental effort and to not find a resource (the singular experience) had to be confusing. Confusion in overload is to be expected. When facing complex challenges in the moment, teachers experienced not having a performance or step, or not having learned or experienced the environment making learning difficult. Just focusing on Gina Hunt's descriptions of her load, one finds assessments of learned performance and resources, the levels of acquisition, and connections of this to the environment:

> It takes a level of consciousness to bring that [performance] into my brain . . . .
>
> It's [the need to do engagement performances] different every day. It's different depending on what's going [on]. . . So it's always picking your battle [what problem to address], how much . . . .
>
> . . . the less clarity you have, which means you're not going to be digging into that bag of tools that you're trying to use.
>
> One thing that really hinders a new teacher's ability in the beginning, if we're expected to master the curriculum and teach it, we can't have so many behavior distractions.
>
> Down the road to today, I know which [fires, challenging problems] are going to be the most active, so therefore you're not running around every fire.

"Figure it out." Nobody else can get inside your head but you.

And I'm thinking, "I don't have that bag of tricks built, so you keep telling me to do this thing that's not automatic yet." "I don't have that yet."

While each of these statements represents a singular and unique experience, each expressed one of the two axes of definciency, that mental resources were not immediately available, or distractions happened in the environment.

A very large number of deficiency statements appeared in the data, in all teacher accounts, after the researcher searched "I don't—" Participants referred to performances, to knowledge, to levels of familiarity, to having responses, to "knowing," like the following statement from Amanda Betz. In this extended reconstruction of her CL, she moved around both axes constantly, naturally, as a singular and unique experience of where her mind went, a measure of deficiencies in environment and in performance. She had been stopped from doing something at a particular moment of teaching, and this was how. One should notice from her opening lines where the action was taking place, her "brain" going through class:

Interviewer: You were just aware there was a problem and—

Betz: Yeah, and I was going to have to fix it before the next time I teach. *I don't know how yet*, but I'm going to have to fix it.

Interviewer: Were you searching for an answer right then as you were delivering—?

Betz: Yeah, I was trying to think. My brain kept going to, "How can I throw in a think-pair-share, or an elbow talk, or something?" And I think I'm just scared to do that with them. *I don't know* if my—I'm sure my management is not as good as it will be hopefully by the end of the year, in the next three years or whatever, but it seems like whenever I release them to do partner work or group work, they're immediately off task and they don't actually do what I want them to do. So my brain, because it works in all my other classes, is like, "Oh, do an elbow share, that will get them talking." But it gets them talking in here but not about the topics. So I'm still trying to think of ways that I could get them to be in small groups and still remain engaged. *I don't know*.

Interviewer: And you do it while you're on your feet watching it happen.

Betz: Yeah. I mean, that's what I do in my other classes. With this specific class, I feel like it's more challenging because I'm constantly aware of the fact that they're probably not going to do what I want them to do. And then it's just more trouble, like getting them on-task again and waiting for them to put their phones away because the moment I take my eyes off of all 39 of them they all have their cell phones out. And that's something that's literally always on my mind.

What was always on her mind, environment (of magically appearing phones) or performance (noticing, getting them on task)? It was hard to tell, for both were difficult in this particular class, both demanded effort. It was a singular and unique experience evoked, but the uniqueness was in how effort and the two axes of environment and finding the performance came together in the moment. The variability of both factors was known in the moment she was describing, pulling apart. She was not doing theory work that leads to learning design, she was evoking what happened as her mind made efforts to decide in her environment, assessing the performances she had acquired, and the particular classroom, and her ability all at once, in one texture. She began with looking at her class, wondering if she should implement a technique (a think pair share, or elbow talk), and was scared, and did not know— what?—she assessed her chances based on her management ability, the performance she had that might hopefully change over three years. Three years of time and experience might hopefully change her performance, she hoped. This, and the rest of the description, was the thinking, was the moment of CL, a moment she was stopped, but she added: "And that's something that's literally always on my mind." What was always on her mind, like a weight, were these decisions in performance and execution, the measure of her deficiencies and chances in this distracting classroom. It was singular experience, in the moment and in different moments, but constant, as she said twice. She was "constantly aware of the fact that they're probably not going to do what I want them to do." Was this because her students were who they were, or because her performances were what these were? She kept thinking about the performances in this class, the environment of this period. When Amanda became aware of something missing, during practice, in the moment, she often said, "I don't know." Her uses in this anecdote described the moment of awareness of a resource, that is, its deficiency. In other accounts, it was sometimes as a pause in the account, a phrase while she gathered her thoughts, but many times expressed awareness of something missing, a practice she was unsure about, *this is what I don't know*. How do novice teachers know what they do not know outside of cognitive load? A researcher or learning designer might easily apply theoretically biased explanations to Gina Hunt's and Amanda Betz's loads and seek to attach deficiencies of learning, but the two teachers described two axes of awareness: defects of resources or environmental distraction. Overloaded novices with failed processes or wasted think-time talked about either (a) the unlearned performance, with or without reasons for its unavailability or (b) overwhelming environmental demands. They would name it or blame it.

In terms of analogies, several teachers also used the image of being thrown into the water as a method of learning to swim to describe what cognitive overload was like. Gina Hunt described the simultaneous problems she met in class and was prodded by the researcher to think of how learning a new skill could take place in that complexity.

Interviewer: What's that like? Having—

Hunt: It feels slightly impossible. So on top of all that you're asking me, what does that feel like?

Interviewer: As you're learning to be a teacher. Learning to solve problems in the classroom.

Hunt: It's just the classic throw you into the water and they swim. "Figure it out." And it's just the only way to learn it is to just be submerged in it. Kind of like somebody who doesn't know a language, and they just drop you off in the country and say, "See you in a couple weeks." And it's not without really careful packing, and here's all your curriculum, and here's this beautiful building, and here's this beautiful master's degree. But essentially it's, "Figure it out." Nobody else can get inside your head but you.

Again, the environment and the performance, the being in the water and the learning to swim comprised the two axes of overload explanation. While the emphasis in this image was on being immersed, that the surroundings overcame the teacher, her description was one of a need to learn. Her current design of learning was to be submerged without knowing how to swim. She compared it to being dropped into a foreign country to learn a new language, an image Ella Finn also used, and implied a suitcase when she acknowledged the "careful packing" of a Master's Degree and curriculum resources and classroom, but these were not enough, and "essentially" she had to "figure it out." Hunt often referenced her "bag of tools" to describe mental resources and performances. Being immersed, even with a well-packed suitcase, with having been given an education and physical and teaching resources, was not enough. Learning to swim was treated as the responsibility of the teacher, who alone could get inside her own head. Being alone, being immersed were the elements.

Ivan Jentz served as a singular example of overload due to massive distraction in his environment. Like Gina Hunt, Jentz experienced overload as being in the water, but he was also swimming upstream. The class observed by the researcher was a chaotic place, and Jentz described how he had searched for techniques to solve problems. He began with some war analogies.

> *Jentz*: That was pretty chaotic, yeah. That was pretty chaotic. Yeah, I mean, when you're at a point where you're just trying to minimize—deal with what you got, and minimize anymore further incoming, you know what I mean? That's chaos. You don't have your—you're fighting to get back to a place where you can get control, right? You're not in control at that point [laughter] in time. You're just trying to regain a place where you can try to get control. Forget about getting control. You just want to be at a place where you can start formulating a plan.
>
> *Interviewer*: Where you can start to formulate a plan. I'm studying with you right now the steps in your mental process as you solve problems. And you say you want to get to that place where you can even have a mental process [laughter].
>
> *Jentz*: Exactly. There were points, right, where you were swimming—well, yeah, you're swimming, and you're not just against the current, you're being taken the other way. You just want to be in a place where you're at least swimming where you're not going backwards. And at that point in time, then you can—it becomes a place you establish that, then you kind of get a plan going, but there are times, yeah, where you are underwater.

"You are underwater," but even if he knew how to swim, the current was against him. He did not want control in that moment, did not want a plan, but wanted a place where he could try to get control, a place where he could formulate a plan. The distinction was important for him. Not only was the control or the plan not available, the “place” to have a mental process of trying or formulating was not available. When the researcher asked him about this distinction, his response was, “Exactly.” Several teachers briefly indicated that there were times in the class where the “fight or flight” (their term) instinct came into play, and that they could do neither. In this case, Jentz wanted to go to another place, a place of quiet where he could put together a plan for what to do. He wanted to get out of the moment, “that point of time.” He had apparently located the source of his load in the classroom itself (a place of chaos, of being underwater) and wanted to find another place where thinking, moving forward would be possible. He was searching, reaching, but reconstructing the overload brought clarity for what his search had become, a search for a space to even have a mental process. Although a chaotic classroom with many interruptions from students might seem the source of overload, often the source was acknowledged by teachers as coming from within. Ivan Jentz further elaborated his mental limits by calling to mind the chaotic classroom he had reconstructed in this prior interview: “So, I think your mental limit is the fact that you’re no longer capable of formulating a plan because there’s too much, as I said, there’s too much interrupting the process of formulating a plan,” again, a relentless activity that is environmental and, perhaps, mental, as the search for a proper formulation occurs.

Reaching this point was repeatedly described by Jentz in reference to the chaos of the classroom, external distractions, the unruliness of students, his own need to simultaneously meet these challenges, along with the wish for a quiet place to “formulate a plan.” He discussed the idea of calling a timeout, and the researcher asked him to develop that image.

> Interviewer: When your wheelbarrow’s too big and your toolbox seems too small, do you have any other things that you do? How do you feel at that moment when—?

Jentz: You're frustrated, I guess. You call a timeout [laughter].

Interviewer: You call mental timeout.

Jentz: You'd love to just everybody freeze for whatever. Thirty seconds would be great.

Interviewer: What would you do in the 30 seconds?

Jentz: Just breathe and just be silent. Just collect yourself a little bit. I don't know. Yeah. Just be out of whatever it is you're in right then.

Interviewer: It's an interesting question. Freeze everything for 30 seconds. You've got a magic stopwatch. You do it. The whole class freezes. . . . What do you do then?

Jentz: Yeah. I think you would just—you could get your thoughts together, you know? I mean, when it's that kind of chaos, you are overwhelmed. Yeah, with just 30 seconds of—Okay. Where am I? So let's come up with a plan. You can't formulate a plan when something's constantly interrupting your process of formulation. At that point in time, you're just reacting, doing your best to figure out what's most important and what's not, but at the same time, reacting to anything that comes in. The constant distraction when everything's up here makes it impossible to formulate a plan of action.

This was a rich description that located the source of overload within distraction, within the environment of "constant" interruption; his classroom made it impossible to solve problems, to learn, to even have a cognitive process. He would "get his thoughts together" in the moment of the magic stopwatch. But what would he think when distractions were gone, what would be the direction of his mental effort? While it may seem that his overload was a result of simultaneous external challenges, simultaneous challenges given by students, what emerged was another real element of the overload. He needed the space to formulate a plan of action. Jentz's desire for a space and time "to formulate a plan of action" indicated two things. First, he described the lack of an immediate, accessible technique or response, something he could have learned how to do. However, he also stated his belief that a solution must be created, formulated in the moment, to meet the challenges of students who were disengaged or disruptive. He believed he was either reacting or formulating. He believed his role, if he was given a thirty second freeze, was to formulate or to design a plan, to invent something new for this environment, even though disruptive and disengaged students are a recurrent element in this classroom. Later, he would describe his need to "sink his fenceposts deeper." His need to formulate, to create also affirmed a lack of immediate techniques with which to respond. The researcher also wondered: if he had had an automatic response, something he had been given, had learned in such a way that he no longer had to think it, this might have been the best solution.

Like other teachers, Jentz was asked questions about his learning design, specifically focusing on how he acquired effective techniques. When asked if he had ever drilled or practiced certain techniques of classroom management, he flatly answered, "No" and laughed. He described how he daily rehearsed in his head the nonrecurrent elements within individual lesson plans, the content he was delivering. These elements gave hints to the real defects he described; learned performances of effective, recurrent responses to challenges were not included in his resources. Jentz was a man who had had a prior successful career in a very technical field, who celebrated his prior expertise and described powerful performances in that career, a man with a high intelligence; he had entered teaching out of an immense passion to help kids. "You have to love them" was his motto, and his accounts demonstrated this compassion. His "defects" were not in a lack of ability or intelligence, as far as the researcher could see, the opposite was the case. In the third interview, Jentz described his learning in greater depth, throwing more light on the source of his overload.

I went in overestimating what I was bringing in with me. The learning, the degree, the experience of having raised [number redacted] kids. I'm older but more experienced—I overestimated how that would impact the class. I also underestimated how unpredictable 30 [students] can be. Specifically given their socioeconomic situation. And I've been told that there were other teachers that had left after a year, and so those things. So, I overestimated what I was bringing, and I underestimated what they were capable of. So how would you turn the clock back? And I can't impact how they come in, how they present, but I guess the constructive question from this context would be how could I impact what I brought in? I think I was well outfitted with the knowledge that I needed. I did my program in one year. And I have to say that I forgot probably about as much as I learned. It came at you so quickly, and to me, it was so new . . . something totally new. . . . So maybe, in hindsight, if I had taken 2 years. I would have . . . retained more of that stuff. And maybe if I had that at my disposal, if it was more in my working memory, then that may have helped me. It may have helped me.

At this point in his description of learning design, he had located defects in his learning as he saw these, that he overestimated what he brought with him to the class and underestimated the challenges classrooms would bring. Retention, forgetting, being given information but not having it at his disposal in his "working memory." He would have liked to turn the clock back, he said, and this in the context of learning. While he acknowledged he could not change classrooms, what kids daily presented, he wondered how he could impact what he brought in? He had been outfitted with what he believed was the needed "knowledge" in a one-year program, but forgot as much as he remembered, for the knowledge was new and came at him so fast, and he had not retained it. The problem identified might be time, but it also retention, the kind of retention that would make skills immediately available in the moment needed, in the end, he lamented the lack of availability of his knowledge, that “if I had that at my disposal,” more in his “working memory,” it would have helped. What he needed was not at his disposal in his memory in an available and immediate way. Like the other novice teachers who experienced cognitive overload, he lamented this lack of availability of tools. Jentz then offered a description of the kind of learning that might have made those skills more available, which would have helped:

> But as far as the learning . . . how do you teach somebody to—I mean, other than simulated, that’s the word I was looking for. Other than simulation, which would probably mean—maybe you use real kids. Or maybe you use kids that are actors and you get 20 of them. And you say, “Here’s your direction. Go in there and try to make that guy do something that he’ll regret for the rest of his life.”

He was laughing as he described this scenario, the “actors” and “direction.” In his first interview, he had theorized that some of his students were actors, their responses were so oppositional he could not imagine them naturally coming up with the behaviors they demonstrated, that someone must have sent them into his class to do the unnatural. Here, he was describing a place of practice where the simulated complexity matched what he experienced in the real classroom. Like several other teachers, he wanted to learn to teach before teaching. In this description, he stated that another group of student actors would have helped him acquire the skills. This would have given him a chance to learn in the only way a teacher can learn:

> The one thing that I’ve learned is that—which was really different from my perception of it from the beginning—the only way to really learn anything is to do it. Yeah, you have to know something about it before you do it. But I thought you had to know a lot more

> about it before you get it, when I first got into teaching. The reality is you have to know enough about it. The sooner you just do it, that's how you learn.

He learned by having enough information, then doing it, by practice. But he had also discovered he was not learning in this chaotic classroom and might need a classroom simulated outside of the classroom. One should notice the process he had gone through. Jentz had reconstructed the mental event of effort, the highest levels of effort, and this led him to distraction and the direction his mental effort took him to in the midst of constant interruption, an imagined place where a mental process could occur. His reconstruction was one of learning and problem-solving, and he described setting back the clock in his learning, what was missing. Reflecting on mental effort invariably took teachers to a place within, where learning actually happens, and may draw out new types of self-assessments from them. He had a realization of defects in his learning in the midst of environmental distraction on a scale hard to imagine. And he needed to do something.

Structural synthesis. Novice teacher participants gave rich descriptions of moments of very high mental effort and overload, the most difficult and revelatory moments of their learning and problem-solving. These were experiences of not achieving goals in the moment, of seconds wasted thinking toward performances or problem responses, a failure to bring resources and performances forward, to have responsive cognitive processes. The "I don't know" of Amanda Betz was a moment in her mind in between having the information about practices and executing, stopped by the environment full of cell phones, a moment of decision involving all these elements, but stopped. The environment pushed Ivan Jentz underwater, where he struggled for a space to even have a mental process, and judged it not there, in a singular experience. It was the opposite of the minimal expense and provision of the automatic, the competency and comfort of a proven, effective and well-practiced habit. Teachers not only identified higher levels of effort, but descriptions of mental limits being reached shared common characteristics, such as the experience of mental resources demanded but not found, deficiency of steps in a resource where only part of the resource was automated, or massive distraction making mental processes and their performances impossible. Reconstructions of overload were not abstract conceptual or theoretical reasoning, but overload occurred in singular and unique moments of performance; none of these singular experiences can be understood apart the immediate judgements and assessments of teachers about deficiencies of resources or distracting environments or both. In other words, participant textural descriptions of these levels of effort become meaningless when removed from the context of deficient resources and challenging environmental factors given by these teachers. These connections are invariant constituents. For example, teachers were unable to formulate a plan, or even have a mental process, in several situations, and revealed that instead of accessing learned, proven performances, they were attempting to create what they could not, or what was ineffective.

A finding of this study is the level of granularity and detail with which novices could describe their cognitive processes when the focus was mental effort in specific moments of the classroom, and the depth of valuations of their acquired mental resources and performances. While awareness will be discussed more generally in the next section, awareness of cognitive overload was always also awareness of the lack of availability of a performance or the inability to complete a process that led to a performance. The moment of mental overload was one of extreme effort and thinking, often in the midst of great distraction and due to distraction, and one of not being able to pull from memory a response. Novices richly described searching for performances, for mental steps, for new formulations, and described the space needed for such formulations as they came up empty. Many accounts of overload already given described how thinking did not diminish during overload and actually increased, but this thinking seemed almost aimless, not finding what was needed to meet a challenge. As Amanda Betz commanded her thoughts during overload, “Get on in there!” and Catherine Doe, seemingly “stopped” on the outside, was thinking faster on the inside; but the thoughts were a struggle, a straining to reach for a performance that was not immediately there. Teachers spoke of spinning, of drawing a blank, being underwater and bourn away by the current, but all spoke of not having, in the moment, a direction of thought available. Because of distraction, Ivan Jentz did not even have a space for a mental process. They did not know what to do, how to respond, and even shut down in one form or another. The lack of *what* was the source of struggle, but the what they lacked could also be described. It was a what meant to be done, a what to perform, a what was noticed or not, a what communicated with a gesture, a what to say in this recurrent situation, that was beyond reach; they could not articulate its steps. The what came out as layered mental inquiries, stacks of questions about student behaviors needing a response or performance.

In this phenomenology, the anecdote allows the reader to experience with the teacher what has been lived through. (cf. van Manen, 2014, pp. 256–257) Teachers described particular lived experiences undergone in the moment of accessing mental resources, of mental effort, and each was evoked as a singularity, a unique event for each teacher, a moment of searching and straining for a response to students or of immediate response to the life-world of the complex classroom. Novice teachers drew on their learning in these singular moments, and discovered their learning. Their mental processes were uniquely theirs. These were no theoretical discourses or conceptual analyses of mental effort on the part of participants. The researcher did not promote or prove a theory; at most, the researcher thought an experience was relevant, and wanted to learn from novice teachers about this experience. They described a phenomenon, and the researcher has identified themes and categorized invariant constituents as is done in phenomenology. The interviews offered mental effort as a focus, and elicited teacher experiences, how their very different levels of mental effort, in the moment, were lived through and given meaning by them.

What was unique to this study was not the theory of CL, but that the researcher explored these experiences and discovered the singularity, the uniqueness of each novice experience. Two invariant themes emerged, essential facts of teacher mental effort which are invariant and predictable principles of novice teacher learning experience. First, in every anecdote of this data analysis, whether teachers explored the experience of simultaneity, automaticity, or overload, regardless of the levels of mental effort, participants joined mental effort with availability and immediacy of mental resources and performances. Mental effort intended resources and performances, and qualities and categories of both emerged and formed themes. These two elements were one, prereflective experience, bound together. Second, participants reflectively evaluated their own cognitive processes with reference to their learning or to environmental conditions. This is a characteristic of participant explanations *about* the first experience, but was also awareness within the moment of undergoing CL.

Each teacher, in expressing his or her own singular and unique moments, also revealed the first invariant constituent: that experiences of different levels of mental effort in classroom practice were invariably and at the same time experiences of the availability and immediacy of specific mental resources. In the analysis section on simultaneity, for example, every anecdote had the singular and unique event, in the moment, of mental effort making available resources and performances: whether Betz shared all the things that went through her head in one effortless swoop; or attached multiple load levels with mental performances done while circulating ; or described the 100% effort of taking apart complex practices in 30 seconds; or her ease of split-attention between noticing and one-on-one help-giving; or Finn dreamed of juggling her 50 things at once without thinking; or Hunt and Long were being broken into many persons due to effort of multiple performances; or Hunt was splitting load between engagement and templates automatically; or described her level of consciousness in the new skill, the effort of a new tactic; or Finn lamented prediction when so much else was going on in her mental process; or Hunt inventoried all that must happen in management during determined attempts to master skills. Effort level was always experienced with resource availability. It is also noteworthy that all of these occurred in the simultaneous complexity of the classroom, as teachers navigated it and made judgments and decisions in response to it. The lived-throughness of each anecdote reconstructing the experience demonstrates, always, an indissoluble connection. The availability and immediacy of resources and performances are known in the moment of mental effort as a singular lived experience. Mental effort was always toward bringing resources and performances forward, into the classroom, and resource availability impacted mental effort. Teacher mental effort was always conscious intention to do something, a strain toward a mental resource for performance, a determined attempt, an exertion-toward. Sometimes a cognitive process was executed by the teacher, sometimes it was a reaction pushed by the class, and sometimes the process seems to have activated itself, but teachers associated the moment of problem-solving and learned performances with levels of effort and mental capacity to perform. While any one might hypothetically talk separately about one or the other, CL or resources, all lived experiences in the moment bound both together. *This* load fluctuation was always *this* change of immediacy and availability of *this* resource. Descriptions of awareness, in the next section, awareness that happened *in the moment*, will heighten and intensify this connection.

The second invariant constituent was that teachers gave meaning to their fluctuations, dependent on mental provision or absence of such resources, their availability and immediacy was associated with either (a) their level of acquisition of skills or performances, or (b) overwhelming simultaneous complexity. Both of the latter must be referred to, in analysis, as elements of learning design. Many of these were not prereflective experiences, not descriptions of *what effort is like*; however, when teachers talked *about* experienced resources and performances, awareness of their learning progress or process or environmental conditions were applied. They often knew why *this* level of mental effort for making available *this* mental resource or performance is *mine*, right now, in *this* moment, and accounted for it in diverse pragmatic reflections on ways they had developed resources or they laid blame on environmental conditions. Diversity of explanations could be expected, and even mistakes in explanation might apply; but questions of why my mind works *this* way in *this* class with *this* performance led to rich realizations about learning process, shifts in learning goals (to automation), and assessments of learning needs. For example, the increasing automation of noticing was associated by all teachers with pervasive and constant classroom demands and ongoing practice; or noticing failed due to massive complex simultaneity. Whether the circle of vision would open wider or the map of fires would become manageable, or performances would become "more not-overwhelming", automaticity was automatically identified as a litmus test of learning through practice. It was not magic or charisma; if skills were considered easy, they were still skills one had acquired.

They described how these typical conditions resulted in overload: the lack of immediacy and availability of learned performances, proven responses, in an environment that demands instant decisions and simultaneous executions of skills, or how they simply stopped functioning during moments of performance in overwhelming environmental conditions. All of these descriptions were given in the context of learning and problem-solving experiences in the classroom, and could be categorized as "defects of learning." Participants described the difficulties of the environmental demands, interruptions and distractions, in passages that have already been highlighted in this section and others. These anecdotes were all singular and unique moments, while teachers were attempting to learn on their feet. But teachers all experienced moments of overload as a reaching for knowledge and solutions that were not there. When the classroom environment overwhelmed them with simultaneous demands they could not meet and with distractions, it was exposed as the source of difficulties by participants. It was no longer a place where learning could happen, and teachers indicated this repeatedly.

The researcher has chosen to call the lack of resources or inability to access resources "defects of learning" or "defects of learning design." This evocation may be controversial, since CL theorists do the same, and it must be clarified. The connection between cognitive overload and defects of learning is not a theoretical construct, but a phenomenon sharing common characteristics described by novice teacher participants; but this must be demonstrated for professional educators of teachers and requires structural analysis. There are educators of teachers who may have never thought in the way participants did, anecdotally connecting mental effort levels with the absence or presence of mental resources, or associating availability of resources with learning provisions (lack of learned techniques) or defects of design (classrooms that made learning and implementing performances difficult or impossible). This connection may seem a theoretical or conceptual bias, an imposition of CLT on experience, if the connection has not been made by a reader. Common characteristics of the overload experience described in singular and unique experiences, however, were the source of the connection, the researcher only echoes teacher experiences.

To begin, and for purposes of bracketing, the researcher should bring to light, once again, one prejudice in this structural analysis, an apparent conflict of learning frameworks. As described in the third chapter, the researcher's background has included training of novice teachers with a preference for learning frameworks of expertise transfer. The researcher has been exposed to a wide variety of techniques that serve as learned solutions to almost all recurrent problems that are encountered within the classroom, and his prejudice includes a strong belief that there are real expert techniques and ways of transferring these techniques that would allow teachers to immediately solve recurrent classroom problems. He has seen all of these techniques automated to varying degrees in expert practice, and believes that there is an exhaustive set of techniques that would help or resolve every classroom problem. The researcher believes in teacher expertise, and in expertise transfer. When the researcher writes of defects of learning, the absence of certain skills and performances, it might seem to be based on these experiences and convictions: e.g., that novice teachers could and should have the resource or performance they are striving for, that since they do not have it the fault is in teacher learning design. Moreover, CLT (one approach to expertise transfer) identifies inefficient load or extraneous CL as a sign of defects in learning, either from the design of learning not providing the proper steps of a resource, or the environment providing distraction. In CLT, this construct typifies the common characteristics arising from learning experiments, "defects of learning and learning design;" but this application of a construct does not mitigate the real defects that are described in the anecdotes of teachers. Defects of learning are also experienced as singular and unique mental events, and teachers naturally identify their own overload moments as resulting from defects. The researcher has listened to participants as they evoked singular and unique experiences in anecdotes, and not arrived at the category “defects of learning and learning design” through theory, but through listening to participants who identified their needs and whose needs had shared characteristics.

Phenomenologists categorize real experiences. Mental effort was associated by novices with two axes of explanation, a lack of mental resources and performances with which to respond to recurrent problems, or an overwhelming environment with excessive demands. In describing these, teachers also asserted a need for support, for advice, for new tools to try, for greater learning, and also the wish for a better learning environment in which trials could take place. Does categorizing these experiences as defects of learning in itself reflect a theoretical bias? Constructivist frameworks also attempt to provide resources for teachers, to overcome what is lacking or imperfect in practice, its defects, through experience, reflection, and new knowledge. Discovery learning is convinced that novice teacher education must engage a teacher meaningfully with the environment. The goal of learning design in these approaches is not automation of “outside” expert performances, but for adults to develop their own learnings in their own ways through meaningful interactions. Teachers are often encouraged to find their own solutions in these frameworks, and formulations of practice through reflection on classroom experiences is valued. However, these frameworks still know that novices need learning, that there are defects to overcome through support. Constructivists may not consider the lack of proven techniques or performances, outside learnings that come from experts, as defects of learning. Instead, novice mental effort might be a sign for these learning designs that teachers need to do more work on their experiences, have more meaningful interaction and feedback within classrooms, and more and deeper reflection in order to formulate their own solutions in an adult way. Still, both frameworks do identify defects of learning with novice teachers, from their experiences. Novice participants all expressed a strong desire for help in overcoming perceived defects in practice or environmental demands. Overload was one way of experiencing these defects, of becoming aware of them (as will be discussed in the next section on awareness). The learning framework is irrelevant to the novice teacher experience of a problem unsolved in the moment, or the mental effort given to striving for a solution or performance. These moments of teacher experience are unique and singular, shared in the anecdotes of this data analysis. These experiences should be heard and understood in all frameworks because of the need to develop mental resources and performances in teachers. They should be heard without theoretical bias.

The researcher did not impose the connection between mental effort and defects of learning, and the connection is not the result of a theoretical bias. The researcher asked all novices to implement a technique during an observed lesson for the purpose of reconstruction later, and teachers reconstructed the performances they were practicing and the lived experiences of mental effort during these. When asked, “What was that like?” they freely connected effort with resources and performances, their availability and immediacy. They were not told to make the connection, it emerged in description. Mental effort directs intentionality to something, in some life-world. Teachers knew, in the moment, what they did not know, what they needed to learn, or indicated impracticable environmental conditions for the trial of skills to happen. Teachers also openly described recurrent practices, problems they were always working on, the complex environment, and volunteered experiences of integrating new performances in challenging classrooms. They described mental workload and concurrently, naturally, assessed their resources and, consequently, their learning. During these reconstructions, the researcher heard accounts of problem solutions and teacher assessments of the resources they had acquired by learning on their feet in the classroom, and from other sources.

Teachers experienced “defects of learning” as they underwent higher levels of CL. They were not theoretical constructs for real teachers undergoing real searches for effective and available mental resources, and who came up short. “Affects of learning” are known by experience, new mental resources are granted by study, trial and error, reflection or isolated drill. “Defects of learning” are also known by experience, an experience often ignored by learning designers, the mental effort that is a direct affect of imperfections and shortcomings in mental resources. “Defects of learning” were lived-through, for example, in the experience of “being underwater,” grasping for mental resources, as overwhelming mental effort met a lack of learned responses to problems in the classroom. Automation of skills might be the best rope, theoretically, but the actual grasping for a rope, the need of a rope in the moment, and the rope being provided by new learnings cannot be questioned. One could only call “defects of learning” a theoretical explanation by remaining outside the singular experience of mental effort and ignoring the experience and participant explanations of the experience.

An important example for this study were descriptions of the classroom itself as an element of deficient learning design. Participants described the classroom as a place of learning, an essential part of their learning design, in terms of their beliefs and as an environment imposed on them for learning. The classroom conceived this way was central to their learning and learning design, according to participants. While their beliefs about learning design will be explored in detail later, what novices firmly stated can be summarized. They believed that time and experience in the classroom, trial and error in the classroom, and all of their interactions in the classroom were the source of learning. Learning was acquired through interactions, problem-solving and trials of new strategies in the classroom, the exact experiences they shared in reconstructions of mental effort. The complex simultaneous classroom was believed by them to be the best place of learning. However, the following fact is important for phenomenological purposes: it is impossible that novice teachers had these beliefs imposed by CLT. No CL theorist would ever affirm these things of the real complex classroom. These beliefs would not have been imposed by the researcher. Novice teachers had them because they embraced beliefs of the learning design they had been and were being trained in: constructivism. More importantly, their lived experiences in the moment of mental effort contradicted their beliefs about the classroom. Specifically, their own reconstructions of deficiencies of the environment, its distractions, and their own desire to prepare performances outside of that environment, contradicted their own strong beliefs, beliefs they maintained to the end of the interviews.

High cognitive load. This is a study of teachers learning in the complex environment, which means in front of students as they try to achieve the goal of real learning. This environment complicated teacher descriptions of high CL. High CL is most often associated by CLT and CTA with attempts to create germane load, that level and type of CL that is "just right" for working and long-term memory to interact; skills and performances are isolated in their designs to prevent distraction, and the learner is given each trigger and step and goal for performances in order to practice. It might be called a middle area between the goal of learning, automaticity, and inefficient distractions and defects that produce overload. High CL is a state of increased learning, where intensity of effort is considered a good thing, and has a positive effect on long-term memory acquisition. It is best studied, according to CLT, in controlled learning environments, with few distractions, where teachers may be allowed to focus on each step of a process and experience its effects.

However, when teachers in this study described introducing new skills or practicing new items of teaching, it was in the classroom, learning on their feet, and they often spoke of simultaneity, the emergence in the class of other elements that made the practice or execution of the one item difficult and the experience confusing. Because teacher reconstructions focused on integrating skills and finding problem solutions in the complex classroom, the optimal conditions for learning were not available; more importantly, every participant flatly affirmed they had never been in a learning situation that isolated recurrent skills to optimize germane load, had never "drilled" outside of the classroom. Some teachers also lamented not being able to prepare skills outside of the classroom, but they had to practice them on their feet, acquire them with their students. The less controlled conditions of the complex classroom, the simultaneity and distractions already indicated, negatively impacted identification and description of high CL.

The participants more easily spoke of automaticity and overload, quickly identifying practices and classroom situations at these levels of load. Novice teachers did not find it difficult to talk about the extremes of mental effort. Even though participants chose new skills they would implement for observation before the second reconstructive interview, these experiences were often chaotic. The researcher hoped that, in sharing their experiences of acquiring a new skill or problem-solving, their descriptions might attach to germane CL or a level of higher load that was not overwhelming, but ideal for learning. Teachers did find descriptions that seemed to match that particular zone of mental effort where the higher load might have been somewhat efficient, but never optimal. Learning had taken place over time, through trial and error, and teachers found words to describe "intentionality" and "focus" and the granularity of thinking through steps, and how this impacted flow. There were several descriptions characterized by the teachers using negatives, as in describing experiences which were *not*-overwhelming, or "*not*-automatic yet," of what it was like to solve problems or learn when classroom factors made this difficult. Most often, teachers described recurrent challenges they were finding responses to meet, reactions that were not-automatic, that they had not fully learned, but that were getting easier through repetition. They described some frustration with these skills, that though they seemed not very complex, their practice took effort in the environment. An important theme that emerged was that as teachers described these challenges, the goal of expertise transfer models of learning appeared: to decrease mental effort through practice. Teachers hoped for the elimination of mental effort. The shift to this goal of teacher learning resulted from conversations about mental effort and from teachers looking at their skills in the complex classroom, and was an invariant constituent in conversations about load.

Textural synthesis. Catherine Doe described the cognitive process that goes into including the skill of positively acknowledging good behavior as a tool of classroom management, a piece of a technique similar to what Lemov calls "Make Compliance Visible." (Lemov, 2015, p. 393) She was asked for a reconstruction of her steps; novices sometimes gave some of the steps in such a reconstruction, and would bring forth the items they had to "think" and sometimes left out what had been automated, revealing the pivots or steps that showed up in conscious memory. In the first part of her description, she described the skill and how she had to "go out of my way" at points to implement it.

Doe: I go out of my way to make sure I'm looking at the kids to see who's doing the right thing. I used to, when I was a student teaching, look for the wrong thing a lot, and my mentor teacher, [Name redacted], she used to be really good about pointing out the kids that were really good at what they were doing. And I noticed that that makes a big difference. And even last year, when I got observed, I tried to do a little bit of both, but then my principal would say, "You just need to focus on the good more." So, I do go out of my way to think about who's doing the right thing. That's what I look for, and I try and make sure I'm doing that more.

Interviewer: Is it a speed bump? Does it occupy a lot of space when you have to?

Doe: A little bit. Yeah, because I just stop what I'm doing in the lesson to be able to go look for who's doing something right. I don't do it automatically.

The researcher asked for more in terms of reconstruction. He posed four steps to her, knowing that the exclusion of any one of these steps made the execution of the skill impossible (these four cognitive steps had to be done, either consciously or unconsciously). She rejected the interviewer's reconstruction, and reduced the skill of giving positive praise for student compliance to the parts, for her, that were just short of automatic:

Interviewer: Okay. You notice though, there's several steps there of noticing the behavior, of framing something positive to say about it, of telegraphing it and publishing it, and then checking the response of everybody afterward. I mean, those are the steps I see. Are those the ones that kind of have to—all of those go through your head or do they—?

Doe: I always think of it, in my brain, as a two-step thing. I find the kid. I say it, and then I walk around to see if they've all reacted to it. I just look for the reaction from the other kids… I don't know. When I'm thinking about it, I'm looking for students that

> look like they're on track, and then I want the other kids to look at them. . . . I definitely try every day to do it as much as I can. And definitely, I still have to.
>
> Interviewer: You still have to?
>
> Doe: So, to look for it, to think about it, remind myself to do it because sometimes I'll pull myself and be like, "[Name redacted], please stop." But then I'm like, "Who's doing something right?" So instead of just pointing out the wrong because it takes a lot more energy to point out the wrong than it does to point out the right.

Her phrase, "I still *have* to" seemed to define a moment of focus and intention. "I still have to" was also indefinite, describing the choice in the moment. It was a phrase that summarized the steps she recounted, "to look for it, to think . . . remind myself." It also indicates that there might be a day when she does not "*still* have to," when the task would be performed, but the mind would not be so much engaged or the lesson flow interrupted by reframing the negative to the positive. Her last statement was convoluted. She had said, in her larger description, that it took more energy to find the right thing a student was doing, to make the positive behaviors her new focus. Catherine Doe later gave a subjective Likert rating (from 1–10) for her level of CL in performing a similar recurrent task of classroom management, quieting the class through a chant or group gesture, and then described how, over a year, her high level of effort had become lower.

> *Doe*: A five or a six because I still have to know what—I have to think about what's going to work the best in that situation.
>
> *Interviewer*: Okay. Do you see yourself maybe lowering that number as the years go on?
>
> *Doe*: I hope so. I think so because then I'll be—
>
> *Interviewer*: Has it already come down?

Doe: Yeah, because I feel like last year, I didn't know the certain situations that would occur because it's so different going from being a co-teacher to being a full classroom teacher. And you don't have someone to ask, "What should I do?" You just have to do it. So, I think, maybe last year it was an eight or nine because I had to always think, "What am I supposed to do right now?" Because I didn't have the situations—I didn't know what situation it was. I didn't know how they would react to certain things. And so, if they were coming in from PE and they were really loud, I wouldn't know what best strategy to use to get them to be quiet again. And here, I just have to say, "This student sat down and did something really quickly," and they would all react to that. But last year, I wasn't sure which strategy would work best. . . . Last year, it was more about exploring what works best when.

Interviewer: What was that like?

Doe: It's kind of hard because you need to think about what you're going to do. Now it's not so hard. Now I don't have to think about what I'm going to do as much. I usually think about what the situation is, and what applies to it. Last year, it was more, I think, about both of them, like the situation and the strategy, and how to put them together.

This was a nuanced description of a place in-between overload and automaticity. In the prior year, there was no one to ask what to do, but only doing it, and a process of "exploring" the engagement rituals that worked best in different situations. It was hard because she had to think about what she was going to do. Did what she thought, her cognitive process itself, change over time?   Notice, she said that in the prior year she had to think about *what* works best *when*, however, presently, "I usually think about what the situation is, and what applies to it." These are the same elements. She is indicating that they are different, trying to contrast them. But these are exactly the same two elements last year as this year. What is different, what she struggles to contrast, is that she doesn't think it "so much" this year. Presently, she had "put them together." The *what works best* and the *when* must still be considered, but these are "not so much," not so "hard." Same thinking, different effort. In the year before, she had to exercise both noticing skills (seeing the situation) and then employ the strategy, to *think* it. It was a time of exploration, within those moments. The skill was not immediately available. After a year, "Now, it's not so hard . . . I don't have to think . . . so much." All that was changing was the mental effort it took to put them together. When the mental resources are present, as is the case here, learning happens. And the increased effort of processing slowly reduces the effort.

Ella Finn compared the experience of higher load to learning the skill of typing or learning a second language, especially in terms of the first steps of learning to type, finding the specific keys individually, before one becomes a fluid typist, putting down whole words and phrases without having to look at the keys. She moved, in the following description, from steps that each required a focus to a point where she did not think of details, she simply did it. The Interviewer had asked what it was like when her "circle of vision" was wide and she could see what needed to happen clearly. Her first two sentences said what it felt like. But to describe this automaticity, how it occured, she suddenly switched from that minimal effort to the kind of learning that required effort:

> I think it feels like—it feels like everything else is easier. So, everything else has become like a second language. It's like typing, like when you learn to type, right? You're hitting. You're like, "Okay, type on the N, and the R, and S and you're typing these words that repeat those keys, right? And when you're first learning to do it, it's like, "I['ve] got

> to look at the keys and I[‘ve] got to look at the words.” It’s super slow, and then pretty soon you know where they are, right? Or even texting on your phone. . . . When you’re texting, if you know where the letters are on your qwerty board, you can text without looking at your phone, right. . . ? You just don’t have to think about all those details. Your mind is open up to adding data to it and it doesn’t feel like so much work. I think when it’s not a second language that the level of intensity and focus on the small, little tiny circle is very, very big. When the little tiny circle becomes easy—when I figure out a way to manage those kids asking me those rapid-fire questions, blah, blah, blah. . . .

The first words of her description indicated something powerful: she was made aware of her automaticity from looking at other, simultaneous skills, “everything else,” and how easy these had become, “like a second language.” She then described how she reached that point, by referring to other learning she had done. At first, when learning something new, intensity and focus on the small parts of the learning, the steps of a process, were very large in the mind of the teacher. The intensity and focus on the small, the “tiny circle” of each step, each moment of performance, disappeared as one no longer had “to think about all those details.” Through this effort in the details, “You just don’t have to think about all those details. Your mind is open up to adding data to it and it doesn’t feel like so much work.” Finn seemed to be moving around in her own cognitive processes, and discovered the mental space she had made by directly describing mental effort and the change that mental effort brings. But her account had an interesting ending. She had focused on the familiar image of learning to type, a “second language,” that was now easy to her, and then affirmed this was also the way the learning happened in teaching, but when she switched to a description of learning to teach, of figuring out a way to manage the kids coming at her with questions, everything became suddenly muddled, and she gave up on her description, “blah, blah, blah. . . .”

Gina Hunt seemed to struggle at times with reconstruction. In the following account, she insists on talking about a technique we had been discussing in terms of a discipline philosophy that is logical and feels good. But there was a massive change in description as she turned inward, to the movements within her cognitive process, what the researcher perceived as a completely different type of description.

> Interviewer: And it seemed to work. It seemed to work. What was it like including that as a new thing with all of this other information coming?
>
> Hunt: I think, for me, it felt nicer. It’s kind of like Love and Logic. Love and Logic feels really good as a discipline approach because you have peace in knowing that it’s logical. And so I think that for some reason it just feels good to be fair and to not always be talking at the students that have the talking problem, but also give some of that responsibility to that really sweet student that’s also not on task, but she’s completely listening to this other student. And kind of teach the whole class that we all have a part to play in this problem.
>
> Interviewer: Everything you say about it is true, and I totally agree with everything [laughter]. But I’m asking more about—when I say including it, what’s it like to include it? I mean, in those moments that you have to think about it, notice the behavior--
>
> Hunt: Yeah, you do—
>
> Interviewer: —respond, and execute.

As she immediately responded, below, the description changed from one of reflection on practice to reconstruction of a lived cognitive process:

> It takes a level of consciousness to even be able to bring that [performance] into my brain to use it because my natural response is to address the talkers. So, I have to have a certain level of clarity in the moment to even pull that. It takes energy for me to have a consistent level of clarity where I can even stop and think about, "No, no, no. Remember you're working on not doing that." So, the higher that fight or flight response gets, the less clarity you have, which means you're not going to be digging into that bag of tools that you're trying to use. So throughout that 30 minutes that you were observing, or 40 minutes, I would say that level of clarity was decreasing because the more things that were getting thrown into the mix, the less likely it feels like you are to be able to reach and use a tool that you're trying to use because you just lean on what's natural.

Gina Hunt expressed an awareness of "that" performance she wanted to learn, that it was there, somewhere within her. Complexity and concurrent mental activities moved her "bag of tools" out of her reach. She described awareness of a change in levels. Energy and clarity and a level of consciousness were necessary for this learned performance to happen. But the level of consciousness, she said, could be blurred or decreased by the amount of thinking or challenges "thrown into the mix." She struggled to "pull" the tool she needed, that she was trying to learn. Whether from distractions or from a defect in the tools available, the tool's availability and immediacy again came up as demanding mental effort. The reaching and using was a central piece of practice and described high mental effort.

But what was the object of her learning intention? What was it like? She compared trying to practice the steps of a new skill to reading a recipe, having the pages available, that the novice needs to look at the recipe and follow it step by step, while the expert does not:

> Yes. I'm realizing that I'm quite an analogy person with you, but I have another one [laughter]. I tend to love to follow a recipe. My mom is one of those cooks that never uses a recipe, doesn't measure anything. I tend to silent covet my recipes. They are in nice looking pages. They are clean. And I have great little cookbook stands where I can see them all. And so I think there are things that I wish I didn't need a recipe for here at school that I could do more on autopilot.

The recipe book was a powerful analogy in that it contained all the information for a performance, but not the performance itself. She consciously intended this performance, but she was aware, mentally, that the performance was not there yet. She tended to "silent covet" the clear, clean, articulated steps. She was devoted also to their ways of presentation, how the recipes were kept before her eye, on "great little cookbook stands." Notice, she had multiple stands, a strange image for the researcher, until he considered again that all teachers need concurrent and simultaneous processes, just as cooks might who are preparing multiple elements of a meal at once. This was an image of her mind that she wanted while specifically learning to teach, not only to have the clear steps of the multiple tasks, but to have all of these before her, for clarity and focus, her recipes with the ingredients and steps presented in a way both immediate and available. This was what learning to teach involved, for she also saw herself in this kitchen without the books, eventually. Gina moved reading from a recipe book at higher levels of focus to this, for "there are things that I wish I didn't need a recipe for here at school." Her Mom did not need a recipe and she wanted to be like her Mom, "on autopilot." The goal of the recipe books was to overcome the "silent covet" and not need a recipe book or a stand.

The recipe book was an analogy. What was it like for Gina Hunt when she actually had the recipe books of teaching opened up for her? What was her experience of learning when the steps were presented to her? She described a shift from expert information to automaticity in the following passage, what it was like to get information, but to not have that information fully available and immediate cognitively, in this case from her mentor. She began by offering the successful result of learning, the reading groups she had finally "wrapped [her] head around" then shifted her description, without prompt, to a part of her learning to achieve this. The recipe book was opened, but something was not "clicking":

> Hunt: So for me, now that I've wrapped my head around what I'm doing at reading groups, the second piece is that it's fully prepped and I can go on automatic now.
>
> Interviewer: Okay. You go on automatic.
>
> Hunt: Mm-hmm. It's no longer a stick shift. It's on automatic.
>
> Interviewer: Yeah. Okay. And you've obviously seen another expert teacher doing it, and that helped. Okay. . . .
>
> Hunt: I was really a little bit puzzled.
>
> Interviewer: But the stress is gone. The stress disappears, you said.
>
> Hunt: Yeah. I was really puzzled— the first few times I brought it up with my mentor, he just kept saying, "You just need to pull from these resources." And I was so bothered by that because I wanted to say to him, "This isn't clicking. This isn't automatic for me." In his mind, he's like, "Well, your fluency group—you need to just pull lines of—you need to do all these different things." And I'm thinking, "I don't have that bag of tricks built, so you keep telling me to do this thing that's not automatic yet." But to him, it was like, "Well, your accuracy group—pull out all your lines at practice. Or you can do this, or you can do that." And I'm thinking, "I don't have that!" Or "you can do this, or you can do that," automatic thing yet. So, I notice that even him as a mentor and expert

> teacher, he would still try to just teach that way. And I kept saying, "It's not clicking. I'm not there yet." So—
>
> Interviewer: Yeah. How'd that feel?
>
> Hunt: You almost don't want to speak up because you feel like, "Okay. He's explained it twice, three times, four times, and it's still not clicking." And you feel like it's expected to click, so you should either pretend that it's clicking and go work on it by yourself somewhere [laughter] by yourself, or you should just be honest and say, "Listen, it's not clicking yet." Or, "We need to build this bag of resources." But that was probably one of the examples that I really felt overwhelmed by, like, "Stop telling me that this should be automatic because it's not."

With Gina Hunt the awareness of both effort and resources led to the awareness of a different type of learning, the exclusion of which was "puzzling." Note, at the beginning of her account she claimed she had arrived at automaticity in reading groups, she had already experienced how she herself arrived, and this reflection about how her mentor helped her get there, however elliptical, is part of that experience. She had put a big piece of the puzzle together, by herself, in her opinion, moved from stick shift to automatic (the car image and car analogies kept coming up with all participants separately!). She said she was "puzzled," and about the learning. It was a practice puzzle. Her account, with her other anecdotes, put together the pieces. The puzzle for her was not the resources or their explanation, nor the theme of immediate and available performances. She had a clear picture of the skills, was clear about automaticity, what both looked like. The puzzle was the type of support she was offered by her mentor, and it should be contrasted with the "level of consciousness" and "clarity" in performing she had described needing in the earlier learning anecdotes. Her mentor had explained the procedures. Her mentor even seems to have been calling for practice, for doing, "do this," telling her to go through all the mental steps in order to make this hers. But he had told her to do it in the classroom, that she could just do it, although she knew she had not been prepared for that. She had to "go work on it by herself," for example, before doing it with students; she wanted another environment, in between the getting of expert information and classroom performance. The focus and intentionality of doing the processes of reading group, the conscious effort she had described elsewhere, what would have made everything "click," was missing. She did not have the performance yet. She had not built the skills yet. She needed more *from her mentor* in terms of practice, she said. She wanted the practice, the doing, the going through all the mental steps, before performing it with the students, that she be prepared. From a frustrated place, in the tension between doing and automating, she assessed her learning and evaluated it based on the absence of the *doing it* that could make the performance present, "automatic for me" before her practice happened with students.

Structural synthesis. All six teachers flatly stated that they had never isolated an item for drill or practice outside of classrooms. Practice for teacher learning was expected to be done in real complex classrooms, where high or efficient mental workload seemed difficult, according to teachers, to achieve. This limited the researcher's and participants' ability to share a full experience of efficient or germane mental effort. The performances teachers tried out during observation often turned to overload, to a struggle that made resources unavailable, but also produced descriptions of things teachers were working on, trying to integrate, as teachers pushed through distractions. The sections on simultaneity and noticing give glimpses of teachers applying mental effort and finding mental space in the often-challenging environment.

However, teachers also affirmed that conditions of higher load helped their learning, in general. Amanda Betz reconstructed many instances of mental effort, experienced in the moment. In the following anecdote, she had just finished describing moments of overload, “And I feel like every once in a while, I’ll be doing that, and then I’ll just blank out on what I’m going to say. It’s happened multiple times. I feel like an old person. But I will be in the middle of a sentence and not know where it’s going to go.” She described “not having cruise control” or not being automatic, and the researcher asked her to clarify a prior answer, about whether the classroom helped or hindered her learning.

> Interviewer: And you cram too much into your mind then you just—
>
> Betz: Yeah.
>
> Interviewer: —close down. Okay. I’m going to go back before I go onto the next question. You said earlier that when I asked you, learning in the classroom helps your learning, does that help your learning, having to face those challenges?
>
> Betz: Yeah. I feel like you don’t want to work out. You don’t want to go run the mile, but it does help you run the mile next time. I feel like even though sometimes it’s frustrating or I don’t think on the fly as fast as I could’ve, I don’t foresee it changing all these complex things that come up when you’re teaching. So, “If you can’t stand the heat [stay out of the kitchen]—” It kind of reminds me of that saying. I get frustrated sometimes, or a bit overwhelmed, or forget what I’m saying and have to kind of refocus my thoughts. But I’m still appreciative that I have the chance to do that, and I want to be able to handle it next time it happens. And I mean, if I don’t have practice, I’m not going to get better at it. That’s how I feel.

Surprisingly for the researcher, Betz was positive about overload. Betz and other teachers affirmed that they had to have practice, or would not get better. Betz appreciated her high levels of load, and looked forward to another chance at handling such moments, moments she was stopped, the next time. These challenges were frustrating, and hindered thinking ("I don't think on the fly as fast as I could've"). It was a mile-long track on which teachers worked out, a kitchen with the heat up. One had to train to run the mile by running. One had to take the heat, because you had to stay in the kitchen cooking (like Gina Hunt with her recipes!). Practice would not change all the complex things that come up while teaching. Like Betz, teachers practiced in the midst of complex simultaneity and overload, experienced frustration, forgot what they were saying, and had to refocus. Like Betz, they all tried to translate the mental effort into something positive, although without many specifics. Many talked about what it was like to learn alone. Teachers had to manage their own higher CL, since recurrent skills were not formally practiced in isolation, and they had to accept the challenges of implementing and practicing performances in the classroom without any controls. The design for practice itself, the moment of doing and effort, was never entirely in their hands, but had to happen in complex classrooms with sometimes unruly and challenging students.

Because teachers had no formal learning design that directly applied high mental effort with isolated skills, the impact of efficient mental effort could not be fully reconstructed. Glimpses of flow within challenging moments were heard in accounts, and descriptions given of intentionality, thinking on the fly, levels of consciousness, and focus gave hints of the deliberate, effortful steps in mental processing that teachers underwent when acquiring recurrent performances. Teachers affirmed that a different environment would have helped; a different environment might have changed the overload section into a high CL and efficient learning section.

Summary. One of the major findings about CL for novice teachers was that it was there. This has to be stated. Novices had endured it, but not had someone sit down and ask, repeatedly and openly, "What is that like?" They had implemented performances, enacted learning, sought to change their practice, but had not been asked about the pervasive experience that accompanied all these activities. Their response was to talk about it, in the context of learning and problem-solving in the classroom. This was a new conversation, which also must be stated. Expert educators may themselves have learned a body of recurrent practices and reduced their CL, and may not be used to connecting mental effort with classroom performances, with learning, to thinking this way. Novice teachers, on the other hand, had a different thinking, since they were struggling to bring recurrent practices along with programmatic learning to bear, minute-by-minute, moment to moment, and their minds were new to everything. It may be tempting for expert educators, because this experience is past, to say the connections novices themselves made in this study are theoretical, to say, "since *we* do not make these connections in our learning design practice, they cannot be real" or "the connection between cognitive load and learning levels is theoretical." But novice teachers described ongoing, singular and unique experiences of shifting mental effort and the unacquired and acquired learnings bound to these experiences, and they did so richly and vividly and naturally. Novices connected CL levels to everything, saw it in everything they were doing and trying to do in the classroom. There were a great deal of unsolicited experiences given through the reflection on mental effort as an object of experience. As indicated in anecdotes, novices ran with the concept through their experiences of learning with great clarity and the validity of personal experience. CL was a phenomenon of learning.

The researcher has condensed their descriptions of types and levels experienced to an essence. The essence of mental effort for teachers was, specifically, the struggle or ease of grasping, in the moment, for immediate and available cognitive resources and performance steps from memory within the complexity (simultaneity) of classroom environments and concurrent mental performances. This level was known in singular and unique experiences that made teachers aware of what they did or did not do in the moment of effort: they noticed classroom needs through cognitive processing, or did not notice, judged what to do through cognitive processing, or were unable to, searched for performances and made decisions and executed complex performances through cognitive processing, or described not being able to do these in the moment. "In the moment" is included in this essence and will be clarified in the next section on awareness of CL. In reconstructing moments of learning, when teachers were stopped, it was mental effort of trying to do something that had not been learned that stopped them; when their performances flowed, often unconsciously, they had learned that task, built it into their memory in such a way that it simply "happened." They described mental processes that different levels of memory made available or unavailable, and that classroom complexity made difficult or easy. Each singular and unique experience in a specific classroom interaction situated levels, cognitive processes, and performances together with natural connections, not theoretical reasoning. Expansions accompanied and were necessary to descriptions of fluctuating mental effort. Novice teachers contrasted availability and immediacy of performances with the unavailable, as their searches became more urgent or less. They associated mental effort with learning, problem-solving, and formal performances in every description. Their experienced levels of automaticity, overload, and high CLs fluctuated depending on many qualitative elements perceived in the moments of processing and performance, such as the complexity of tasks, defects of learning and distraction.

As described in the structural synthesis section on overload, teachers experienced the singular connection of mental effort and availability and immediacy of resources. They also described defects of learning in terms of resources and effort and with reference to distracting environments. Although CL theorists describe such defects of resources and distractions in learning design as extraneous load, the theory was not imposed on teacher accounts, but arose naturally when teachers reflected about their lived experience. The type extraneous CL was not the reduction of experts for the sake of analyzing learning design for novices, participant descriptions were expansions in the hands of novices, with each element communicated as unique to each teacher and learning path and classroom.

However, commonalities emerged in teacher experiences. This grasping for and activation of resources occurred while teachers searched for performance solutions to the ongoing, recurrent problems of the classroom and sought to meet classroom goals, and it also fluctuated when teachers sought to include new performances. Teachers, unaware of dual process models of cognition were able to judge differences in mental processing, where certain habits were effortless due to levels of recurrence and practice, or effortful. The sensed fluctuations in effort. They sensed mental space through limitations of activity and active displays of liberty. Their minds simultaneously grasped and activated resources for new performances. The immediacy and availability of resources determined the qualities and levels of the experience and the efficiency of the grasp. Immediacy and availability were the passions of novice teacher problem-solving and learning and qualitatively evaluated the limits or limitlessness of mental resources.

When the resources, the skills or problem solutions, were immediately available, or simply happened, the mental performance had been acquired. There was little or no mental effort in grasping, only instant action. Because some performances were pervasive, always active, teachers demanded an absolute immediacy and availability of their resources, performances such as noticing or engagement of students demanded instant availability during simultaneous challenges. When the resources, the skills or problem solutions, were not immediate or were unavailable due to defects of learning, the performances did not happen or were missing steps and the effort of grasping for resources increased as the need for the performances increased. When the skills were not immediate or difficult to grasp due to distractions in the complex classroom, the effort of grasping for resources increased as the need for the performances increased. The effort of grasping almost always occurred as concurrent mental resources and performances were demanded, and resources and performances pushed over and through other processes. Teacher learning made the resources more immediate and available through exercising mental effort, intentionality and focus. The "circle of vision" expanded from a narrow focus of targeted learning; the map of fires diminished, one fire at a time, through effort.

This question focused on types and levels of mental effort. A more theory-bound approach would have looked at types of memory (e.g., long-term memory and working memory), or how teachers experience "dual process" learning. According to CL learning theory, certain complex skills with multiple steps are eventually chunked into large schemas and are treated as one item in working memory; when they have not been so built up, the steps of these skills must be cognitively processed individually in working memory, occupying more mental space. Performing a complex task as one item in working memory has less effort. Teacher anecdotes did describe different processes performed in different ways and a spectrum of mental resources all according to their effort. Nothing teachers said conflicted with the dual process model of learning reviewed in the literature review; in fact, teachers indicated repeatedly that they had automated complex processes to a point where their minds did them, without thinking, a sign of long-term memory "chunking" that cognitive psychology describes. Teachers indicated with new items a limited mental space and higher levels of activity, as in working memory. They described a spectrum of effort, and, one may infer, a spectrum of memory associated with that effort, attached to that effort. It could be said that teachers resolved the search for resources in either working memory or long-term memory, but had a strong preference for what, and sometimes whatever, long-term memory offered. They dreamed of having skills immediately available, skills that simply were enacted without using a lot of mental space. Teachers even complained that their habits, their "natural response," their automatic practices intruded on good practice. Simultaneity of teacher mental processes in order to meet the demands of student learners was the unwritten, but often expressed goal of teacher learning, and making skills more and more immediately available through practice served this goal. When resources were not immediate or available, classroom teacher learning had not happened. Trial and error, time and experience, and the classroom as teacher do not seem to provide the resources in themselves, and the information teachers receive in the form of feedback or advice, even from other expert teachers, was not immediate nor available upon reception. Teachers aspired to make resources immediate and available in the moment.

The Second Research Question

The second research question asked, How do novice teachers become aware of their own CL? If CL is to become relevant to teacher learning design, it is important to study how teachers perceive fluctuations in their own effort. Before the interviews, novice teachers had not engaged in formal discussions of their mental effort during learning and problem-solving. While none of the teachers were familiar with the construct, and in a sense were made aware of it in these interviews, the facts and situations of mental workload associated with complex learning were known and perceived by them in their minute-to-minute experiences as teachers. However, forms of attention can happen without awareness, as when a teacher is attending to class, but not noticing what is actually happening; or a teacher can be consciously searching for his next performance and undergo high levels of CL associated with this processing, but not be aware of the load. It would seem that consciousness, cognitive process, and attention must be dissociated from awareness.

This account from Ella Finn is a good introduction to issues of awareness. In it, she was looking for a deeper awareness of her class, which turns to a deeper set of awareness skills for herself. She tried to call what she was describing "reflection" but it was obvious she was struggling with this label, and dismissed it herself. What is interesting is that even though she did not have the word "awareness," she was describing exactly that, a knowledge suited to the moment, the real situation of classroom teaching:

> Oh, I think the classroom is helping me. I think that the students are helping me. I think the only piece that's hindering is that ability to really see what happened. So, like, I know something happened [laughter], good or bad, or maybe both, but being able to—maybe it's a reflection. I don't really like to call it reflection. I feel like we don't have to—I feel like that almost is overused at this point. I mean, I think it's good to step back and say, "I could've done this," and to me, that's a self-correction. Maybe it's reflection. I think reflection is kind of touchy-feely and not really—I mean we can write a lot of esoteric words around it, but it doesn't really help to get to the end. So, for me, I think that

> seeing what happened in the complexity of the classroom is the hard part, and deciphering how to fix that the next time around and remembering how to fix that is the cognitive piece to me. Because I can get into the same situation, and it's like I cannot pull—there's so much going on, I cannot pull that piece that I was going to remember to do out of my back pocket.

She was describing awareness, but not having this word, drifted into "reflection" instead. Real reflection happened for Finn with expert observers and was a piece of programmatic learning this teacher was accustomed to. But here, it was "maybe reflection" she tried to describe, a term she "does not like to call it." "Reflection" did not get her "to the end." Reflection on her practice seemed somewhat "touchy-feely" and used "esoteric words" and was dismissed. She could not find the word, thankfully, since it drew out her description of the phenomenon of awareness. The classroom was helping her to learn. However, she wanted to "see what happened," in the moment. "Seeing what happened in the complexity of the classroom," was the hard part, the skill of awareness. She was aware that deciphering and remembering were the cognitive piece, the cognitive process. In repeated situations she struggled with, she could not pull out the performance. The class distracting her kept her from the process, even from awareness itself. Awareness was a skill she wanted.

Reconstructing experiences in interviews allowed teachers to both attend to and become aware of elements within their experience. While mental effort in multiple processes may not have seemed relevant to their learning before, teachers attending to learning and problem-solving experiences had new experiences of and described new directions for awareness of moments of mental workload. As teachers reconstructed their experiences and described what their mental workload was like in specific instances, they described also how they became aware of the phenomena. The sources of awareness were both external and internal. Teachers found the environment, which split their attention, and student knowledge made them aware of shifts in their working memory. They also experienced internal shifts through their emotions, time sense, physiological changes, but most were simply noticed variations in their cognitive processes "in the moment," and, as has already been described, by awareness of the availability and immediacy of resources and performances. There was a powerful diversity of ways teachers demonstrated realization, perception and knowledge of their mental effort in learning and problem-solving.

Textural synthesis. Awareness is knowledge of a situation or fact. It refers to the ability to directly know through sensory perception or feeling, or to be conscious of events; in general, it is the situation of being conscious of something. In the case of this research, awareness is a mental process performed on a mental process. Awareness is an experience of a lived experience. Lived experiences of cognitive processes or classroom interactions have more information than awareness, and awareness is attention to aspects of lived experience. When the researcher asked, "What was that like?" of experiences of mental effort, or classroom complexity or performance, teachers described elements of experience that made them aware of their mental effort.

Student knowledge. Teachers were made aware of their CL by their students. "Student knowledge" refers to how students know their teachers' levels of mental effort and communicate this knowledge to teachers. It is knowledge communicated to teachers by students, a knowledge external to the teachers.

Teachers were always noticing students, and acts of noticing were identified as increasing CL, but the "student knowledge" that titles this section does not belong to the teacher. Sometimes teachers worried about student behaviors, could predict them, and these events were associated with increased CL and the awareness of CL, but this, again, is not the question. Teachers were aware of greater mental effort as they responded to students, and even classified their classes based on increased complexity and "effort." Teachers described their different periods, universally, based on the level of challenge their different periods offered: it was the go-to descriptor. They all had that one period that they feared, and for Amanda Betz this was the third period.

> But third period has been interesting because they used to be fine and now they're starting to—something's happening in that where it's like they're getting—these classes, I don't think—they don't stay the same. Some of them that are *here*, meaning they're not a big challenge for you from a management perspective, may go up *here*. They may go down *here*, and the ones that are *here* may come down. And that's what I've experienced, and maybe that has to do with me.

The levels of complexity that students brought were what made the introduction of students to the question of awareness of load difficult and confusing. All novice teachers made judgments regarding their particular periods' easiness or difficulty, the amount of mental effort they would expend for a class based on class sizes, behaviors or responses to material, and the skill of noticing was all about a teacher responding to students in ways that would increase his or her load. Teachers spent a lot of time describing their students, their thoughts about their students as they were giving a lecture or redirection, or how they measured student engagement, all of which contributed to load. To be clear, teacher awareness of CL is not the same as the already described noticing skill and its consequent load.

One association stuck out to the researcher, however, during interviews. Ivan Jentz was the first teacher to directly describe it. His classroom was a relatively chaotic place on observation. In talking about his awareness of his own frustration and distraction in the face of students who went out of their way to be distracting with him, he described a confrontation with students who had made him aware of his level of learning.

> *Jentz*: And I think that that's a function of them being 13-year-olds. That's a function of me being a first-year teacher. I think that that's at least there. And they told me that.
>
> *Interviewer*: They told you?
>
> *Jentz*: Yeah.
>
> *Interviewer*: What've they told you?
>
> *Jentz*: "Why are you getting so upset? Mr. [Jentz?], it's just your first year. Come on." And what does that mean? Why would you treat somebody like that just because they're new at something? I don't understand the logic of that. So just explain to me, if that's the way it is and you guys all—then tell me why because I need to know. And I think I deserve to know. "Nah, it's just the way we—it's what we do here. It's how we are." I don't understand that either. Why's anybody just like that because someone's new? That doesn't make sense to me. That's not how people treat other people. That's not how I've ever seen people treat other people. That doesn't make sense to me . . . and when you press them on it, there is no reason.

His students communicated their awareness that he was a novice teacher and treated him accordingly. He experienced this ongoing. He also noted, in another place, how students admired a local expert teacher, and seemed to treat him differently. The researcher reflected that this signifies that students were aware of a teacher's levels of expertise, and sometimes indicated a very high awareness of it. How long does it take a classroom of students to learn that a truly expert teacher has walked into the room? A rowdy group of students meet their new teacher for the first time, on their first day back to school, after the first bell: they hear and see the calm finesse, the light but formal tone of voice cutting the noise, the admonishing phrase that is equally compassionate and strict, and see the stance and squaring of shoulders, how the teacher's face moves across the classroom and changes from a gracious nod at an attentive listener to a small frown at the opposite corner, a frown that is enough. If they see it all happening at once, simultaneously, the students may simply know. What the researcher wonders is at what level students are aware, and if they could sense automaticity, say, through simultaneity in teacher performance? While perceiving simultaneous elements of teacher practice being enacted at once, they might know that the teacher has a level of automaticity, a higher level of skill. Perhaps they can sense the difference between a teacher reacting and a teacher drawing from resources for teacher performance. We cannot explore, in this study, what ways students sense the levels of expertise they experience in teachers. However, students communicating that their teacher was new was an ongoing experience of novice teachers. Amanda Betz described how perceptive her students were:

> But something what hinders [practicing my noticing skills] is when I'm too worried about the actual content that I'm teaching or too worried that they're going to sense that I have only taught this once before or something like that because they're perceptive. They may not seem like it all the time, but they are too. They're picking up on social cues and my

> body language, and my facial expressions, and my tone, and inflection, and my proximity. They're taking in all that whether they realize it or not. And I know that so I get paranoid about it [laughter], and that hinders me.

Several teachers acknowledged that students "kept score" during novice teacher behavioral management. Novice teachers recounted students giving advice to them, coaching them, letting them know that another, more expert teacher, did this or that. Some students demonstrated compassion for the worst moments of a teacher's day. More often, teachers remembered students who were like sharks, sensing blood in the water.

> Yeah. Yeah. Oh, yeah, I had a student say today say like, "I know you're a new teacher so you've never had experience with someone like me [laughter]." And they weren't being nice about it. They were being mean. So, I think that that is an issue. I haven't broadcast it like, "This is my first job." But at the beginning of the year, they were all obsessed with how old I was, if I was married, all this personal stuff [laughter]. It was like, "Do you ask [Name redacted] that?" "No." "So why are you asking me [laughter]?" So yeah.

One student made Ivan Jentz aware of her perceptions in what he called a powerful learning moment for him as a teacher:

> I took her outside and I said, "Look, I don't know what to do. What would you do?" … and she [the student] said "Well, you are kind of like an aunt or grandmother right now who comes over and babysits. You're not the parent, you really don't deliver a consequence to anybody, so if you want my opinion—

Students could sense levels of expertise, and they made teachers aware of it. It is not irrelevant to this study, to the simultaneity of complexity or the increased load of teachers, as Kevin Long indicates in this description of the powerful combination of elements in his overload:

> Well, it's stressful. I mean, I feel like I'm kind of going—like I was saying about being inconsistent, I feel like I'm letting certain things go that I don't want to let go, like the kid calling her a bad name or the kids who are off task. I don't want those things to happen but I can't address them because I'm busy working with this student who is actually getting somewhere. And so I'm wondering, a lot of times, what are the students thinking of my—what are they thinking of my character in a way that I would let that slide or that I would let that go? Are they wondering, "Hey, if those kids are doing those things then I guess I can too." I don't know. I'm always just kind of thinking of what is the students' perception of what's going on. And honestly, how is that going to affect them and how is it going to affect me as a teacher. . . . I feel it doesn't demonstrate who I am or what I want to be doing. But because there's so much going on, it's like I can't put out every little fire. And so I just worry that some of those fires that aren't put out, the kids see that. The students see that.

When asked about his mental limits and what they meant, Long immediately said that at moments of overload,

> You get the kid's attention, I think, because they notice that you're kind of at that breaking point. And they realize, "Oh, man, he's not able to respond right now." A lot of times, they see that, they're like, "Oh, I better do what he was asking me to or whatever." So yeah, I think the students notice it.

Students sensed overload, and possibly other levels of CL. And they made teachers aware of what they perceived. Most novice teachers expressed anxiety for their students over their having a new teacher, and this anxiety was a primary motivator for acquiring new skills.

Skills teachers utilized to bring engagement, which were almost as pervasive as noticing skills, were unique in that students indicated and communicated so much to teachers regarding teacher ability or inability to access those skills. Catherine Doe was asked when she was really aware she has a skill completely acquired, and immediately responded:

> When it's smooth, when I feel like I did a good job, and the kids are happy [laughter]. And they know. I feel like they always can kind of tell when they've done it well and they know what they're doing because they seem happier because they know the routine. They know what they're supposed to be doing.

This teacher seemed to be talking about herself, her expertise, *through* her students. There was awareness teachers communicated that comes through the class. Amanda Betz was also asked the same question, about her awareness regarding acquired skills. Again, there was a powerful sense of connection with her students communicated, a mysterious link that brought a higher awareness:

> Interviewer: How do you know when you have something [a performance] down pat?
>
> Betz: Oh, gosh, I don't. I don't. I don't know [laughter].
>
> Interviewer: You don't know [laughter]?
>
> Betz: I feel like I'm always someone who kind of second guesses myself, and I'm never one to be like, "I perfected this today." But I feel like somewhat I can tell with students' self-esteem whether they're more comfortable seeming with the Cold Call. Or we've been doing—I've been doing number talks which are like—maybe look at some blocks

> and you figure out what's the pattern, or what's going to happen next, or how could you use mental math to do this, like really approachable things at the beginning of the class period that puts everyone at the same playing field. So, whether you're behind or you missed all last week because you were sick, or you don't feel comfortable with math, "Here's some blocks. Let's play with them." And I feel like I've been able to see—I wouldn't say I perfected it, but I've been able to see a really big difference in engagement. It still peters out towards the end of the 73-minute period, but when we do those number talks at the beginning of the period, engagement is so much higher.
>
> Interviewer: So you feel like—I mean, while you—you don't feel like. You understand that you've improved when you see that change in them, that they're more dialed in—
>
> Betz: Yeah. Higher student engagement.

Teachers were aware of their students' perceptions of them as performers. As described above, teachers associated automaticity with effective student engagement, and all teachers associated expertise in general with having a fully engaged classroom. When asked about which skills, among those she was juggling, she would like to automate, Ella Finn described her students:

> I think strategies for creating a classroom with full student engagement, where I have no issues with students being not engaged . . . if they came into my classroom and they were like, "This is the coolest place to be. My mind is fully engaged. I can't think of anything else I'd rather do." If I can figure out the key to that.

"This is the coolest place to be" is a communication, by a student to a teacher, of expertise. Also, as stated in the section on automaticity, the more automatic a skill became, the more effective it would be, several teachers said. On the surface, this did not make sense. The automaticity of a skill in a teacher, in itself, would not seem to impact its effectiveness, unless, that is, the students give the teachers some sort of feedback about their better skills, or unless students respond better to experts than to novices, and can perceive their expertise through characteristics of their performance. Teachers were made aware of their performance and aspects of their learning, possibly including their CL, by the people observing them most, their students.

Split attention. This section does not describe what CLT researchers have named the "split attention effect," but the title describes teacher focus. Teachers attend to the complex simultaneity of classroom problems, and their attention is taken to different places and people at once. When student responses or classroom happenings split a teacher's attention (almost always), the perception of simultaneous complexity and multiple problems needing solutions made teachers aware of increases of CL. The first research question section (above) presented teacher descriptions of complex classroom simultaneity, especially surrounding the noticing skill, and focused on this unique source of CL; the anecdotes present moments of awareness as well. Teachers became aware of increasing levels of mental workload, or even their own levels of automaticity in certain tasks, depending on how much their attention was split at moments, and how they navigated that split. When asked in her reconstruction to measure her CL in a task, an exercise in awareness, Amanda Betz replied:

> I don't know. It doesn't seem that complex, but you are doing a lot of things while you're doing it. Because you're still trying to carry on a lecture, and you're still trying to monitor the people that were being good while monitoring the people that you're trying to fix their behavior. I don't know. A six or a seven.

She was asked for one task, but immediately described everything occupying her memory, the multiple mental resources she was trying to access. Lecturing and monitoring were also going on, which increased the level in her measure. She measured her CL based on her awareness of split attention. In some cases, teachers knew that a task was automated because it could be done simultaneously with other tasks, and the attention could be split. In other cases, teachers were distracted and this increased their mental workload, even to the point of overload. Several teachers spoke of the class size as impacting CL,

> Betz: I think just my mental-ness, just my mind is expecting—it comes to expect a rough period, which is bad, but in my head I'm like, "Okay. Third period." I don't do that for any of my other classes, but I kind of dread third period, because I just don't have a grip on them. I don't know.
>
> Interviewer: Your radar's up a lot more?
>
> Betz: Yeah. It's definitely up more, which pulls me away from the content.

Betz described her split attention in this way:

> There's lots of things going on that you have to split your attention between but [maintain] 100% effort. You can't just half— you know what?—the job and expect it to get done . . . there's so many things that require your attention at the same time that sometimes it's hard which one to do first. And I feel like that's what I do in my head. Okay. What is instant right now?

Awareness that the attention was split, the sense that multiple problems needing multiple resolutions were pressing in made teachers aware of their load, and, in the sense described in the prior section, may in fact have been the load. Most cases of high CL were associated by teachers with their attention being split and distractions being present, as indicated throughout the last section. Teachers were aware of how much they had to notice, and repeatedly described "how much." Sometimes attention was split so much, teachers were outside of themselves. Usually, Amanda

Betz focused her awareness descriptions inside of herself. In the following, she was completely outside of herself, and attention to the external environment was overwhelming.

> I think every once in a while it does happen where everyone is talking at the same time, and I know in my head that 90% of them are off task. So I'm mentally preparing myself to figure out, "Okay. Am I going to count them down? Am I going to do a countdown? Am I just going to yell? Not yell, but am I going to have to speak really loudly? Can I do it from where I'm standing, or do I need to get up there really quick and then I can get their attention?" That happens a lot when there's like—they try to do it when there's like 10 minutes left of class. But specifically, when there's only a few minutes of class left, it does feel overwhelming when they all try to get up and go to the door.

Her attention, like Jentz's, was overwhelmed when chaos broke out and she had to reach for multiple solutions at once.

To condense this section on split attention, the researcher refers to the first sections on simultaneity and noticing skills; these experiences of high CL or automaticity within the simultaneous complexity of the classroom were also experiences of awareness through split attention.

Emotions. The researcher was surprised at how little emotions were associated with novice teacher descriptions of their mental effort. CL was not an emotion, although it was often described as "felt." Felt was a word used often when the attentive and noticing part of the mind focused on another process. For example, even when teachers said they felt "overwhelmed" they described this as amounts of information to process, and not emotion. Reconstructions mostly surrounded the issue of how teachers perceived complexity and how this impacted the mental processes. But emotions entered the cognitive process. Teachers were all passionate about their jobs and having an impact on students, and their feelings were revealed in their triumphs and failures. The word most often used to describe emotions surrounding CL was “frustrated” or “frustration,” a feeling generally associated with the inability to change or achieve something. When teachers learning to teach reached for tools that were not there, or were unable perform, they were powerfully aware of inability, or frustrated. Also, some teachers spoke of anxiety regarding their performance, that in the execution of some task they would somehow fail their students.

> Interviewer: Some of your feelings get involved in that?
>
> Betz: Yeah.
>
> Interviewer: Okay. What are those feelings?
>
> Betz: Anxiety, worry, I guess stress, anticipation but not in a good way. Anticipation of just blank stares coming back at me.
>
> Interviewer: That’s your nightmare, isn’t it?
>
> Betz: Yeah. Oh, yeah. That’s like the absolute worst.

However, Catherine Doe had the opposite reaction to her anxiety. She is describing her stress here in the context of learning new things in the classroom:

> I like the high anxiety level of it. I think I make good decisions when I’m under stress because I know it’s going to impact other people.

In other parts of her account of her teaching, she indicated how proud she was to be in a job that required complex responses to simultaneous problems. Gina Hunt offered some of the most visceral descriptions among the participants. When Hunt had acquired a skill, she described her awareness in emotional terms:

> You stop stressing about it. It no longer is a part of your stress laying in bed, thinking about—it all of a sudden just—your brain recategorizes it, I think. So, for me, it’s those

> things that you're always stressed out about, they haven't been addressed fully because you're still having anxiety about them. And then it's like certain things that—for me, reading groups, I've noticed that I don't have near the anxiety going into that hour of the day.

Again, she was noticing the changes, and her changes in emotions reflected the new awareness of learning levels.

One emotion that had the most powerful descriptions was that of guilt, and teachers associated it directly to classroom complexity and their search for a skill to meet the needs of students. Teachers all wanted to do a good job. Guilt happened when a teacher found her attention divided between students with different needs, when simultaneity and the lack of responses both "spread a teacher out" and tore a teacher up emotionally. It was associated with the discovery of limitations in the face of student needs. Gina Hunt was discussing her cognitive overload and was asked about her feelings associated with it.

> I would say, if I'm not feeling guilt about not meeting her needs, I'm experiencing dealing with her and feeling guilt about not meeting everybody else's needs. Because I have a student over here who [she listed different students with different personal needs related to hygiene and home life]. And I'm giving this other student over here, [Name redacted], the biggest slice of my one-on-one time. So, I'm happy to be serving her, but I'm experiencing guilt for not being able to also address this other student who has this gaping need as well, but it's like the squeaky wheel gets the grease. So, guilt is a struggle, and I would probably guess that a lot of novice teachers feel the same way because you're spread. It's just hard to spread yourself. And so that affects your confidence when you're feeling a lot of guilt. I feel expert teachers don't feel as much guilt. They figured

> out how to compartmentalize it or look at it differently. But I feel like novice teachers have a lot higher feeling of, "I feel terrible that I can't meet this kid's need." Whereas somehow, down the road of experience, the guilt goes away, and it transforms into something else. But I feel as though right now, it's very [well] named as guilt.

She associated her guilt with the level of mental effort, a search for responses to problems in a complex classroom. The inability or inaccessibility of the skills that will meet a range of needs has become an occasion of guilt. Several teachers described the difference that being in the classroom made on their learning as being an intense feeling of responsibility, that the stakes were higher now, in the classroom, because of their students. When asked for more information about how she saw the "difference in her learning now" that she was in the classroom "learning on [her] feet," Amanda Betz gave her most emotionally intense and passionate description, beginning with the statement, "I think I'm emotionally impacted by [the learning] more…" and then described how she felt about her students, and the instances she took her responsibility home with her every night, because she was "super-invested." As she spoke, she became emotional, more intense, and her last sentences were loud. She wrapped up her description, her voice gaining greater and greater strength, in the following. Her first word refered to her need to learn:

> It's just all more intense, and I remember things more because it has context. So yeah, maybe in our MAT class they said, "When a student comes in and wants to use a different pronoun, this is what you do." And obviously I'm super'sensitive to that and always really respectful, but it's different now because I do have students who, every couple [of] weeks, change the pronoun that they want to be addressed by. And so I'm constantly staying up on the Internet stuff of, okay, what pronoun do you use if they don't want to

> be male or female? What do you do if you slip up? How do you apologize? It's just really personal now because they're *mine*. They're *my* students. They're not my Cooperating Teacher's anymore. They're *mine* and I'm responsible for positively impacting them. And it really, really matters!

The researcher sat, stunned, at this description of the change in her, from learning in University to learning in the classroom. She felt a great passion for her students as she described her passion for her students. This description is given because such feeling of responsibility is the emotional impact that novice teachers felt as they reached for solutions for their students, and their learning was very personal. When they struggled for the skill or technique that would bring a change for their students, very powerful feelings arose to motivate them, and these accompanied their learning and pushed the effort to new levels.

Teachers also gave descriptions of being excited or happy at events in the class, usually associated with student engagement, but at times with the ease of a particular skill. In a very powerful emotional account, Ivan Jentz described what it was like in front of the class, performing when he experiences the energy of "being in the moment":

> Again it's like being [a tight-rope walker] without a net. That's the thrill for anybody that does anything like that. That's why they do it, anything can happen and this could go anywhere. This is the challenge of making sure that you have memorized your lines because you have a responsibility to do that. Now you're proving something to your class, you are proving something to yourself, you're in the moment. In the moment, anything can happen in any given second that can pivot. I'm over—I'm exaggerating, because nothing is that dramatic in the classroom. Well, maybe it is, maybe it is. I get excitement from that, whereas somebody else may not.

The excitement of performing well was expressed here, and in one way or another by all teachers, of being able to find the tool needed or the words needed in the moment. This description led the researcher to an even deeper reflection on being "in the moment" that is described below, and also impacted the entire analysis of anecdotes.

Time sense. While descriptions were not altogether similar, there was a consistent awareness of a time being stretched out or shortened during both automatic and heightened levels of CL. Teachers were aware that their sense of time was changed by different levels of mental effort.

> If one's automatic, I just feel calm and normal. If it's not automatic, I feel like I'm a little—and my anxiety level rises because I feel like I don't know how long it's going to take because it could be taking like five minutes in my brain, but it could be two seconds to the kids. So, I just don't know how long that will take.

While the students may experience only 2 seconds passing, for Doe it seemed like 5 minutes might go by when she was thinking at a higher level of CL. Teachers struggling to access skills and the steps of skills had a sense of time change. In the case of Doe, the faster she was having to think, the slower time got; she could also be talking about expectations, that she expected herself to be faster, and felt she was moving too slow. Or perhaps she just felt "the moment" passing, the moment she had to act, and, as it slipped away, time was stretched. Teachers had "the moment" to make a decision, and the 2 seconds felt like 5 minutes.

Amanda Betz described a change in her perception of time: "there's so many different things going on at once and that first one that you talked about when you were like, 'Oh, yeah, and that was only in two minutes,' it's so true. So many things can happen in just 30 seconds. It doesn't seem like that long." All teachers talked about the need to do something or other "quickly" and the classroom full of simultaneous problems needed quick responses. Amanda Betz described the urgency of the classroom this way: "What is instant right now? I need to take care of this and what can be on the back burner for another minute? So, I'm constantly analyzing number one, two, three, four, five, what I need to do first." Betz also used "quickly" multiple times to describe the kind of thinking that she had to do, and it was a firm part of her vocabulary of describing her thoughts. However, when Ella Finn described how she admired another colleague who was an expert in classroom management, she hoped to be able to identify problems and, like this expert, "just manage my own mind enough to think through that in nanoseconds on how that's going to go." When Finn described her learning steps, when she first began learning a skill, it was "super-slow." Whether due to the demands of the classroom or the actual or required speeds of thought, there was an awareness that automaticity and higher levels of mental work stretched time. The knowledge that teachers aspired to was often described explicitly or at least implied to be "instant." To have such speed, the researcher must surmise, created awareness of a relative distortion of time.

Physiological. Some teachers became aware of their bodily changes due to added mental effort.

> Hunt: When I do something automatically, I— it's funny when you said that my first thought was when I do something automatically, my body is at rest. So, my heart rate, just that overall tension that's up in your chest, and in your neck, and in your shoulders, when I'm on automatic, my body is at rest. My breathing is good. My heart rate is normal. Things like that. When you're on autopilot, I feel like my body is kind of like a runner's. A runner gets in that rhythm and they're good. But, initially, you're like, "Huh." You're huffing and puffing, so yeah.

Interviewer: So, "When I do the things I'm still working on, I—"

Hunt: I'm more tense. The physical response is palpable. When you're really being intentional, you're tense. You're tight. You're really trying to execute. You're reaching. You're straining.

Amanda Betz and Gina Hunt exclusively focused on their physical changes when undergoing CL. Both described, several times individually, instances when their "heart rate" increased due to mental workload, and that overload directly impacted the heart.

Interviewer: And what's that like for you when—?

Betz: Oh man. Physically? My heart beats really fast, and I feel like—honestly, sometimes, when I'm really frustrated, my voice starts to shake, and I know that, and then I get self-conscious about that.

Betz's self-conscious feeling came from the worry that her physical signs of stress might make students feel bad, that students would sense her physical changes. Gina Hunt also described the lack of heart rate, lack of physical stress that automaticity brings about.

Interviewer: So how do you know that you're done paying off your interest and you've gotten past that kind of surface to something deeper?

Hunt: I think there's an automated sense that you require less checking in with other novice teachers. For me, it's going to have to do with heart rate. I think that when somebody walks into my room and does a random observation or something, that you'll just be in your lane. And it won't affect you physically as much. Those two things, for sure.

Interviewer: Yeah. You've mentioned the physiological measurement of how much load you're dealing with, all the information coming at you before. So you really feel that?

Hunt: Oh, yeah. It's a physical manifestation. Absolutely.

Interviewer: You're one of my only teachers who has talked about that. Tell me what that is.

Hunt: Well, every teacher wears deodorant. Because if you don't, everybody is going to know when those physical manifestations happen [laughter]. And I would venture to say that I bet every novice teacher thinks very specifically about that in the morning. Because we probably sweat more under the pressure, than somebody who's not feeling under pressure. I don't think it's about physical [activity]—all teachers are moving around the same probably. But it's that physical reaction. And so—

Interviewer: So, you'll just be juggling up there, and won't even feel any stress when you get there.

Hunt: Yeah. Less physical manifestation of stress, for sure.

She claimed that the stress was not from teacher physical activity, but that their reaction to their levels of mental effort, to both automaticity and higher levels of CL, would be accompanied by physical manifestations of either rest or stress.

Awareness of mental limits "in the moment." The immediacy and availability of resources and performances were known "in the moment" by all teachers. Teachers spoke explicitly of "the moment" in accounts, but the moment was also present even when not directly invoked. Teachers spoke of sensing or feeling being in the moment, and the moment made them aware of their mental efforts. Ella Finn gave an interesting description of this awareness that related to her "circle of vision" and tunnel vision. During Finn's interviews, the researcher felt frustrated by how she would turn the conversation to her students' learning and their CL, as she seemed more inclined to speak of their experiences; the researcher let it go, listening to see what came up, and waited to bring together her description of one student in particular and turn it back on her, to have her describe herself. One of her most animated descriptions was that of a student experiencing frustration in her class, and of how she and the student resolved it. Ella concluded the very detailed story:

> And we talked about it. He was calm. We talked it through and he saw it. It came back to this whole thing about, you're in the moment, you can't see outside of your person. You can't see outside of your thinking and bring in a different piece. Anyways, it was a very interesting thing that happened.

"You're in the moment," was a statement that interested the researcher. It is an important concept for phenomenology, where the moment represents, usually, a singular and unique experience. Being "in the moment" where one cannot see outside of one's current thinking or bring in another piece is a description that applied to increased mental effort, but also awareness. It did not seem to refer to a point in time but encapsulated an intense experience. When each step of a process takes great effort, the focus is narrowed. Because of this final description, the researcher turned her moving story back to her.

> Interviewer: And this kid . . . it's almost like he's got a lot of cognitive load going along as he's trying to focus, and he may have missed something while you were doing [that problem]. Because he's got relationships. He's got other classes. He's got getting here and getting out, and the assembly's coming. And he's got other things going on in his life. And he's having trouble focusing. And you talked about the stream of thought and getting him connected with [it] so he can connect the dots. And in some ways, learning to be a teacher is a lot like that. You got into the kid's head really well. . . . Do you ever go through your own—look at your own learning in the way you looked at his just now?

> Finn: Oh, I think so. I mean, I tried to. I mean I think that's part of even just sitting down and talking about feedback about my observations. Clearly, she's [her principal] sitting on the outside looking in and I'm in the tunnel vision of my learner role, right, and teaching role and I get sucked in. I get sucked into the kid's coming up [during class] and [surrounding her desk]—because I like to work with the kids. I like to work with two kids here, and three kids here, and two kids here, and do that. But I think that also is that tunnel vision like what I'm talking about [with] him. He's up here just going down this rabbit hole and he can't see around him. And so I think I'm totally guilty of that. I totally see myself there.

She gave two awarenesses. The first was lived through "in the moment," with a sudden realization of "not being able to bring in a different piece," and then a description of her own activity, of her own tunnel vision, of walking down the tunnel in her practice in a way that narrowed her focus, took her down her own "rabbit hole." The awareness of CL here was brought about through a narrowing of focus, an awareness that her thought had been taken through a funnel, an ever-narrowing "circle of vision" and into a narrower tunnel. As Finn described, "you're in the moment, you can't see outside of your person . . . you can't see outside of your thinking and bring in a different piece." This description highlighted her sudden awareness of thought's limits in a moment of time, with an inability to bring in a different piece or to see all the pieces, in the moment of teacher learning or teacher problem-solving.

This was an invariant description of thought's limit, the effort in the search for a solution or the steps of a solution to a problem, or how memory reaches for a technique and its steps. While in the moment, "You can't see outside of your thinking" was a central and clear description, one which many of Ella's analogies of her "circle of vision" and "tunnel vision" moved around. The teacher recognized herself as situated in a particular mental process which had an outside. The situation inside made seeing outside difficult, if not impossible; the teacher had, in this image, gone down the rabbit hole. This awareness happened "in the moment."

Did this awareness, this moment-of-going-down-the-funnel, happen for other novice teachers? Mental effort was a vigorous or determined attempt to access what was in the mind, a sometimes strenuous mental exertion, a straining for or toward specific skills and their effective steps. In the classroom especially, efforts happened in the moment, during those times a teacher was learning on his or her feet, or on the fly. There was a moment of teacher learning and problem-solving, and teachers were aware of it. Anecdotes evoked this moment, as in this example from Amanda Betz.

> I feel I'm getting better at automatically doing it. And even since we reflected back on my last lesson, I've tried circulation a lot more. . . . So I don't know. It's kind of hard to put into words because it all just goes through your head so quickly.

The moment made teachers aware of the immediacy and availability of a performance. Effort occurred in the moment. Teachers were made aware of the moment by the need for it. But teachers also explicitly described "the moment." The researcher performed a search of "moment" in the eighteen interviews and was surprised by the number of instances and uses, usually at the center of important and vivid reconstructions. The following anecdotes are representative of "the moment." Before proceeding it is important to recognize that the availability and immediacy of resources and performances is always, in each anecdote, and took place "in the moment." The moment was the frame that tested the immediacy of resources grasped, and was a moment of cognitive effort. The researcher noticed the use in this exchange with Catherine Doe, a moment of knowing the performance she wanted:

> Doe: And so I think when I—when I'm thinking through having them do that, it's a moment when I know that I want all the students to feel like they have enough time to solve the problem, and they have enough time to think to themselves. To not be judged or peer pressured by other students. And I think that I just—when I'd want to give it is—I'm trying to make it so that that moment is open for all the students and not just the ones who know it.
>
> Interviewer: Right. Is it a moment of decision, in the moment, or do you plan it beforehand?
>
> Doe: I think it's usually in the moment because sometimes when I do collaborative conversations with the students, I don't always do that. . . .

The moment was one of decision, which involved multiple complex processes. Sometimes the decision was not made in the moment, the effort was absent from the moment, but the moment itself was a cause of distraction, as in this description of Ella Finn:

> So I do all those things. Probably the thing that I do the least of is quietly communicate with the boy sitting right over there who's disrupting class. I would probably go over and say, "I need you to be quiet," and be very direct, and everybody will know that that's his warning. And so it's not a conversation we have privately. Maybe I should do it privately, I don't know. And that would be something I'm not really very good at, because it's in the moment and it's always when we're trying to accomplish something and—

The moment was important for a teacher's classroom learning, learning to teach. Classroom learning and problem-solving always happened in the moment, and awareness of availability and immediacy of resources happened within the moment, as Ella Finn indicated:

> But they're essentially around this topic of seeing it happening, juggling how to fix it when it's happening, knowing something happened, and thinking about what you can do to fix it in the future, but then knowing it in the moment, pulling it out of your pocket in the moment to fix it before it happens, or to make more out of it when it does happen.

Novice teachers struggled with the moment, and its challenge was found in immediacy. The moment also demanded focus, and, in some instances, being "in the moment," and fully with the students was lost with the loss of focus. Distractions could deprive Gina Hunt of the moment:

> And so I would say that's one part of being in teaching that I don't enjoy, is when I'm being observed because I'm trying to focus on that what's-coming-next piece with my observation, and I can't quite just fully be in the moment with my kids. I don't know if you've ever heard that before, but—

The moment could be a moment of triumph or enjoyment too. "But that's the beauty of it in the moment you're in, you think you nailed something, and that's what you need to keep you going." When Jentz enjoyed the execution of a skill, it happened in the moment.

> Now you're proving something to your class, you are proving something to yourself, you're in the moment. In the moment, anything can happen in any given second that can pivot. I'm over—I'm exaggerating, because nothing is that dramatic in the classroom. Well, maybe it is maybe it is.

Thinking for teachers happened in the moment, and skills were accessed and performances came forward in the moment. In many of the most detailed reconstructions of thinking, the moment was evoked, the moment of thinking or non-thinking, of being able to process thinking. It had to be a process that could take place in the moment, or perhaps it would not happen at all. There were moments that passed without the performance, where the thinking did not happen, but the teacher was still aware of the moment, even without the performance, aware of the classroom opportunity that went by, as was the case with Kevin Long.

> Well, it definitely was uncomfortable. I mean, I would have liked them to be back in their chairs and back to how it was before we left. I didn't think of this in the moment, but I should have just had them go back to typing for a few minutes and just, "Hey, I know the timer went off. But hey, let's just—" I could have said, "Hey, finish out your lesson," or whatever. Now looking back, I'm like, "Well, I should have just had them go right back to typing for three minutes."

The moment might have been one of reaching into the toolbox of mental resources, and the moment marked when a choice was made or a resource was found. The moment was one demanding a response which might not happen, as Ella Finn indicated:

> It becomes easier to talk about it and to practice a little bit more and they're like, "Oh my gosh, why did I think this was so hard yesterday?" So I think having patience with that toolbox is really important, and I don't often think of that at the moment, but then later in the day I think about—that happens for me, and I've seen it happen for them, so.

Novice teachers saw their thinking in that moment, a process framed in it. An entire thought process that could be dilated was described by Kevin Long.

> Yeah. I kind of am guessing. I'm wondering if it's going to work. I'm wondering if I'm going to get the result I want. So, when I do the countdown, in that moment of counting down, I'm like, "Okay. Hopefully, they're going to be quiet because if they're not quiet, I don't really know what I'm going to do [laughter] if they keep talking," other than try it again or—

The researcher, reflecting on teachers' being "in the moment" arrived at two meanings, each surrounding the essential meanings of the moment or moment. People often refer to the moments of their lives, in the sense of having elusive and passing events, of their moments coming and going. The moment of mental effort during learning or problem-solving was an exact moment within awareness, in the temporal sense, and the moment of cognitive processing involved the novice in a strain toward making a multi-stepped, complex process happen in the now, a performance that was impossible to reduce to simplicity, to a here and now. The researcher has described immediacy in terms of resources and performances, that is, that teachers expressed a certain urgency to be met, that deeper learning could provide. Teachers needed resources in the moment. The moment was always present in reconstructions, whether explicitly referred to or not. The need for simultaneity described in the first section, the "at once" and "at the same time" of teacher demands, invoked the moment. As Finn's primary analogy, the river, evoked: cognitive processes coursed through participant minds like a river, being moved by a classroom's constant change, and the teacher had to respond in the moment, make the moment of performance happen or allow it to simply pass. The thought process was made to happen in the midst of this flow, it did not simply happen as with the expert. But the moment could pass quickly, as teachers often described when exploring what was demanded of them. In the moment of mental effort, what must happen must often happen now.

There is another meaning of "moment." It refers to importance, to the substance and value of an event. An event of moment bears a weight within a movement. When classroom events are "of little moment" then they are insignificant. But classroom decisions may also have great moment. In the Latin and scientific term *momentum* one gathers this other meaning, a combination of weight and velocity. The heaviness of the moment was conveyed in the above anecdotes. Teachers reconstructed their decisive moments and indecisive moments, and the cognitive process was challenged by and itself impacted the moment. Something should have happened in the moment, or did happen in the moment, and it gave weight to the moment. The situations expert teachers respond to and the skills they strain toward have great moment but seem to have even greater moment to the novice. The moment of teacher effort required them to undertake and make present a cognitive process, but at a learning level when the complex skill they were still acquiring was new, the steps were separate. Like momentum, the moment of CL was also the product of mass and velocity, an impetus gained, a force of driving behind a process or course of events. The effort requires momentum, a thrust within the steps of a skill or performance, it's energy to push through the other cognitive processes or classroom happenings.

Awareness of being situated "in the moment" of novice teacher learning and problem-solving involved both meanings, a combination. Performances of moment must be made to happen in the moment. Unsolicited, novice teacher participants described how time's elusive passing brought about urgency in moments of challenge and decision, and that which had to be done had weight. In unique turnings toward and awareness of their cognitive processes, the moment emerged as one of challenge, awareness, decision, grasping, enactment or inaction, a moment in which complex happenings within and without met. What for the expert may happen instantly, what may also be "of little moment" for them, often might happen unawares. Novices were very much aware of the press of time and the weight of steps as they sought to make available solutions to recurrent problems or to learn steps of a new process, the moment within the moments.

The life world of the teacher is defined by and met within the moment. While learning design will be discussed in the Fifth Chapter, it is appropriate to indicate here that the goal of automating performances and resources, making them available in the moment, is made more urgent by the awareness of teachers of the moment. Teachers experienced their practice as having to happen there, with strength and speed. They expressed wishes to fill specific moments with their practice, but at times the moment slipped away and they expressed their disappointment. If they could process more and faster, have resources that were more immediate, their moments would not wastefully go by, but could be moments of productivity and efficiency. It is necessary that learning design take the moment into account, the simultaneity and concurrency demanded in the moment to meet different challenges “at the same time” or “in the moment.” It is not enough to provide teachers with information about teaching, but learning must reach its fulfillment in the moment.

Structural synthesis. Teachers did not abstractly describe CL, or theoretically reason to it, but reconstructed experiences and described awareness of parts of the experience. A confusing problem arises when one introduces awareness, the question of how teachers become aware of CL. Awareness is not needed to perform cognitive processes, and this was given in the data in several ways. Experiences of automatic performances indicated that these required less awareness even though the processes seemed stronger and better defined. When teachers described noticing, they all indicated there was much that goes on in a classroom of which a teacher was not aware, and that they wanted to notice more, to see and hear more, to be aware of what they were seeing and hearing. Seeing and hearing were always happening for teachers, sensory processes and information was always coming, but they were not aware. In the experience of CL, teachers appeared to struggle in the moment for information which they could not fully incorporate, behaviors and words that were somewhere, in memory, but could not be brought into performance. The happenings within and outside of a teacher's mind that resulted from constant interactions were larger than a teacher's awareness; awareness was only one piece of what the mind was doing. Theoretically, in the most general view of living systems, cognitive processes can occur without awareness. Maturana and Varela (1980) developed the Santiago theory of cognition, based on autopoiesis; cognition is considered as the ability of adaptation in a certain environment, and it applies to all organisms; when a system interacts with its environment, cognition emerges, a transfer of information and adaptation occurs. They encapsulated their theory in this way: "Living systems are cognitive systems, and living as a process is a process of cognition. This statement is valid for all organisms, with or without a nervous system" (Maturana & Varela, 1980, p. 16). In other words, awareness was not needed for cognitive processes to happen. There was much that went on in a classroom and in a teacher's mental process of which a teacher was not aware. This is significant for two reasons. First, the researcher cannot simply point to a teacher's lived experience of a cognitive process and affirm this was also a description of awareness; simply having a process does not make one aware. Second, awareness is a uniquely situated type of knowing. Awareness needs direction, a conscious intention to know or perceive something.

Awareness belongs uniquely to the person who is aware and at different levels. While the interviews asked "What was that like—?" and looked at the moment of performance, teachers directed their awareness to places that surprised the researcher. The simplest-seeming expressions within interviews resulted in complex directions of awareness. Awareness was unique and singular to each moment, its own mental process (*being aware of*—) but applied to multiple other mental processes, sensations, feelings, learnings, and assessments of strength. Interviewed teachers exploring their practice offered awareness moments like this: "However my brain changes and how I change the wording on things or whatever I'm doing, it's a mix between me and the kids, and it's just not quite working as well as it does in my other classes." In that moment, she was aware of (a) changes in her "brain" (something going on in a different part of her brain other than the part that was being aware), (b) a change in performance (changed wording and doing), (c) an awareness of "a mix" in a difficult class (interactions) and (d) a performance not quite achieving her goal. Each different awareness came together in one experience. Awareness was also here: "But most things, I feel like—the main things that I know that I have to do, I can shove all in there, and there's not really like a mental limit." She was aware of (a) the main things, those with high priority, (b) of shoving these performances (or "cramming thoughts" in other anecdotes) into her mind, and, in doing so, (c) was aware that she has not felt the limit. A key phrase, "I feel like" saturated participant descriptions of awareness, and did not refer to emotions, but usually to one part of the mind aware of another part. A key phrase, "I feel like," was a verb that had nothing to do with emotion, but with having a sense, an awareness of something elusive; there is no verb specifically for how one part of the mind is aware of another part and so she said, "I feel like," and other teachers also said this often to describe their awareness. Again, Betz used "I feel like" to evoke awareness: "I don't think I'd go higher than a five because I still feel like I'm on task, and I'm talking, and can monitor everyone else, and answer questions as they come up." She was aware of (a) a level of mental effort (5 on a scale of 1–10) and gave this because several factors made her aware, including (b) she was performing simultaneous tasks at once and was on task, including (c) talking, monitoring, answering questions. When the mental process that regulates noticing and attention was applied to *mental effort in classroom performances*, new awareness was the result. Teachers stated *what* they knew, *what* they had come to know, and the awareness arose through a focus on lived experiences and thinking about their lived experiences.

Similarly, other teachers described awareness that arose from attending to mental effort and mental limits in attempting new performances. This is a small sample of statements that represent the multiple items of awareness that emerged in reconstructing singular moments:

> So, I think [my] mental limit is the fact that [I'm] no longer capable of formulating a plan because there's too much, as I said, there's too much interrupting the process of formulating a plan.
>
> I'm trying to do all these things simultaneously and teach at the same time, and it's just like "Whoa, too many things at once!"
>
> Sometimes when there's too much, I feel like I'm not doing what I should be doing. I wonder, "Why is there too much?"
>
> So, I have to have a certain level of clarity in the moment to even pull that. It takes energy for me to have a consistent level of clarity where I can even stop and think about, "No, no, no. Remember you're working on not doing that."
>
> You just don't have to think about all those details. Your mind is open up to adding data to it and it doesn't feel like so much work.
>
> It's kind of hard because you need to think about what you're going to do. Now it's not so hard. Now I don't have to think about what I'm going to do as much.

The simplest of phrases contained multiple directions of awareness. Here, teachers were aware of (a) not having a cognitive process due to "too much" from a class, (b) effort to perform multiple items, at once and simultaneously, (c) the feeling of an absence of techniques that would relieve CL, (d) an awareness of clarity, (e) of the moment, (f) of the amount of clarity that would allow one to perform, (g) of energy, (h) of a cognitive process interrupting another and reminding the teacher of performances she was trying to avoid, (i) an awareness of an automaticity where the details of performance disappeared, (j) an awareness of a mental space opened to add more information, and (k) the result of such space being less mental work, (l) an awareness of difficulty due to the need to think, to focus on what one was doing and, finally (m) an awareness of cognitive processes done without so much thought. These were not theoretical reasoning, but directions of awareness while reconstructing experience. The eighteen interviews themselves directed teachers to new awareness, not by imposing theory, but through inquiring about cognitive processes and the effort these took. Shifting attention in this way led to new awareness about their learning and mental effort and cognitive space. Teachers were not told what to say, or to explain their experiences in a certain way, but were asked about how they experience effort levels in learning and problem-solving, from which their own awareness found direction. This was a powerful finding.

Even when Amanda Betz repeatedly said, "I don't know what to do!" in evoking a moment of overload, her mind was integrating classroom situation, the strength of her processing, her ability to find a learned response to a student. She was reconstructing her attempt to process information, sensations from the environment, goals, feelings and thoughts in order to make a decision and guide her next behavior. She was aware that something needed to be done. She was aware she needed to do it. She was aware it was not there. If she had never been asked the questions about cognitive processes and mental effort in the moment, "What was that like?" would she have become aware of what she did not know? Would she have been aware *that* something was mising? Or, in the life-world and flow of day-to-day interactions and cognitive processes, would what she does not know have simply remained “incognito” and anonymous? What did awareness of CL bring?

Real learning, learning activated in the moment, learning as described by teachers, was having performances immediately available. This was a new awareness in the sense that it was situated, a level of mastery revealed in the moment. The intentional focus to reconstruct their mental effort led to awareness of their performances, but also was its own type of awareness. Repeatedly, in every description of teacher awareness in the moment of CL, teachers indicated that performances were *somewhere* in memory, that a cognitive process *could have happened* in the moment, and it did or not, or, like Amanda Betz, all teachers said they were aware that *something* was totally *missing*, and this was an important awareness. Teachers had been learning performances and cognitive processes, and were aware that they were learners and knew what they were trying to learn for “the moments” of their practice. These teacher learnings, problem-solutions, and performances were not static information, but teacher awareness in the moment of CL revealed that *this* performance had been learned to *this* level. Even the awareness of simultaneous complexity did not confound this awareness but enhanced it, making it awareness of multiple process that existed in a limited mental space, awareness that lack of mental space could shut down a process. Awareness of *these* simultaneous demands in *this* moment, required *this* performance at *this* level of automaticity. Or, on the other end of the spectrum, awareness of *these* simultaneous demands in *this* moment hindered *this* performance at *this* level of CL. These directions of awareness belonged to novices in the moment, and this was a powerful finding.

However, to acknowledge that “awareness of mental effort was also awareness of learning” is not saying enough. It does not reach the profound levels of knowledge and perception novices themselves communicated, the depth and granularity of awareness they achieved in looking at the most seemingly simple cognitive performances. What will be demonstrated in the following data example is how one exploration of mental effort in one of the most automatic performances of teaching was like an earthquake epicenter, gathering strength as awareness radiated into multiple elements of the experience of learning. After an hour of reconstructing experiences of mental effort in one observed class, the researcher asked Amanda Betz, “How much mental effort did circulating require? Because that’s the one I noticed, compared to other things, you just seemed to do effortlessly.” The researcher understood circulating, a technique of strategically moving through the classroom to increase engagement, what Amanda called “proximity.” He knew its goals of owning the classroom and using proximity for engagement, and the standard mental processes teachers employ. He also saw this as one of the simplest, most automatic of performances. He wanted to hear about whether she clearly understood the steps and goals of this technique, and if his outside awareness of her ease of performance was also reflected on the inside. The researcher asked for a quantity of effort. However, her exploration and his own responses became a source of wonder to the researcher, because the directions of her awareness, a novice’s new awareness, were more profound than his could be, even as an “expert.” In the following, “DA” represents direction of awareness, as these are described. Note also her first four words, which represent awareness activity, not an emotion:

> I do feel like [circulating] does pull my attention (*DA: split-attention*) off of what I’m saying. I don’t know. It’s so weird, because I feel like I can think about what I’m saying (*DA: ability level*) but at the same time think (*DA: simultaneous thinking*) about, “I’m going to go stand by [Name redacted] because he hasn’t stopped talking the last 30 seconds.” I don’t know if—it definitely pulls me out of the flow (*DA: the automatic performances occuring*) because I think in my head I’m doing it because something negative

> happened (*DA: classroom noticing*), and that's why I think if I worked [circulating] in I'd be better. But it's always, at least right now, for me good or bad, is because someone's being distracting (*DA: trigger for performance, in the moment*), and so that's why I do it. In my other classes, I've become more comfortable with just doing it just because (*DA: automaticity, it activates "just because"*), and I don't know. I guess, I don't think about it as much (*DA: level of CL*) with them. I wouldn't call it automatic (*DA: some mental effort*), but I don't think that I get bumped out of the flow as much as with that class (*DA: level of challenge, complexity*). And it probably—

The researcher tried to interrupt at this point, to get her back to "*his* question" as *he* saw it and as *he* would have attended to it. The researcher was unable to wrap his head around these first several sentences. She had gone to her real performance in her real complex world, where a performance was not simply *this thing* that took *this effort*, but different consisted of multiple levels and types of awareness. However, the researcher was the expert and wanted to hear *something else*. Her awareness took utterly unique and singular shapes he was unaware of in the moment of the interview, and she ignored him and continued to follow the directions her awareness was taking her:

> —is because it's not a negative thing that I do it in other classes (*DA: the trigger noticed was different*). It's just like, "I'm tired of standing in the front, so I'm going to stand back here and talk." (*DA: her mental process in the moment*) I don't do it because that back group is talking, but that's what happens in my mind (*DA: noticing talking usually triggers circulating*), and so I feel like even just that tinge of—I don't know if it's negative, but that tinge of having to do something (*DA: access engagement tactic*), because kids aren't paying attention I mean it's kind of annoying (*DA: her distraction*), honestly.

> I understand why (*DA: empathy*), but it also is annoying, because I'm talking, and they're talking, (*DA: distraction in the moment*) and it feels disrespectful (*DA: emotion*). And that's kind of what goes through my head (*DA: mental process in the moment*) like, "God, is he serious? Is she serious? Are they really Snapchatting right now while I'm trying to teach them?" (*DA: noticing, moment of classroom awareness*) So it pulls—

She was listing these strange vibrations she felt from her class. The researcher interrupted her again. To him, she seemed to be circling the airfield and not landing the plane. What about the simple circulation? The researcher based this on his own awareness, in that moment, of what circulating was. Betz obviously had a profoundly different awareness. She was exploring multiple levels and types of awareness of her learning in her life-world. The researcher interrupted, wanting to know about this "third period" and to see the differences between this period and others, what *he* was interested in and wanted to attend to. She complied, and clarified these differences, but even in this she continued narrating awareness of *this* class (third period) in relation to *her* performance there and *her* effort, and *her* specific level of learning. This, again, went on for some time. Then the researcher remembered she had not given him her number, her quantification of circulating on the Likert scale (1–10), and went back to the original question, using language Betz had used prior to this to rephrase it.

> Interviewer: I'm studying changes in your mental space. So, let me ask you this. When you're circulating, on a scale of 1 to 10, where 1 is no mental workload at all—you don't even know you're doing it—and 10 is your brain completely "blanks" before you have to do anything [laughter], on a scale of 1 to 10, what would—?
>
> Betz: Oh gosh.
>
> Interviewer: What would circulating today have been?

Betz: It's like a four or five. (*DA: mid-level CL*) I don't think I'd go higher than a five, but [circulating] definitely just pulls me out of (*DA: simultaneity in the moment*)—if I have a thought of, "Oh this is good. I'm going to bring this up, or I'm going to touch back on what this student said earlier," (*DA: mental process*) I feel like I can't do that when I'm circulating because I'm thinking about who I need to go stand by and if they're quiet, and continue talking, and staying on task, but also looking to see if their cell phones are in their lap. (*DA: five automated noticing elements–awareness of class*) So, I feel like there's more things going through my brain (*DA: high CL*), but I don't think I'd go higher than a five (*DA: not-so-high CL*) because I still feel like I'm on task, and I'm talking, and can monitor everyone else, and answer questions as they come up (*DA: simultaneous performances as signs of automaticity*). But I wouldn't go lower probably than a five. (*DA:* "*Goldilocks" finds "just right"*)

The next phase of the conversation, what followed, was absolutely strange and disconcerting for the researcher. He next asked her a question about the actual complexity, outside of the classroom, outside of the moment, of circulating; what theoretically could be called the intrinsic load, the actual complexity of the task of circulating.

Interviewer: Okay. So, with this class [it] is a five. How complex was the activity on a scale of 1 to 10, do you think, the actual just circulating—as you learned it in school?

Betz: I don't know. It doesn't seem that complex, but you are doing a lot of things while you're doing it. Because you're still trying to carry on a lecture, and you're still trying to monitor the people that were being good while monitoring the people that you're trying to fix their behavior. I don't know. A six or a seven.

Interviewer: It's even more complex an activity than your actual mental workload.

Betz: Yeah. Yeah.

She had gone from a "5" in her classroom practice, in the moment, with all its distractions she described, to a "6 or 7" when the skill was isolated, by itself. What was happening? In CLT, the level should be higher in the actual classroom, with its distractions. But Betz had understood what I was asking, "It doesn't seem that complex. . ." However, she wanted to drive home her awareness, to make her point, the point of the whole discussion, and listed once again the simultaneous things teachers must do when circulating. "It doesn't seem that complex. . ." to *you*, she was actually saying. The researcher was attempting to simplify what she would not allow him to simplify, what she, in the end, adamantly refused to simplify.

Only later did the researcher recognize this exchange as a revelation of his own lack of awareness of circulating, and Betz's much deeper, more profound awareness. The researcher presumed his expertise gave him awareness, that his expertise included awareness. He was wrong. The real awareness was hers, it belonged to the novice teacher, explored by her attention to CL in the most recurrent performance of teaching. The expert was unaware. The novice was aware. It was easy, the researcher reflected, for an expert at this recurrent practice to dismiss circulating as a source of CL. Was it not the simplest skill in the world of teaching? For Betz, even to arrive at a specific CL required a huge number of directions of awareness. For the novice, the focus on mental processes and CL was a vehicle for a journey of awareness.

When the researcher returned to other anecdotes, the finding remained the same. Reconstructing "the moment" was always being at an epicenter of learning awareness, whether Ella Finn was noticing moments when the river raged, or Gina Hunt was making reading groups "click," or Catherine Doe ("It just happened") was transitioning students from desks to carpet, or Ivan Jentz stood on a chaotic battlefield dealing with "incoming" fire, or Kevin Long wrestled with his projector as he lectured. They were aware of singular moments of performance and mental effort, and multiple awareness moments resulted. "What was that like?" turned "the moment" into an epicenter of learning awareness, and multiple vibrations were felt. This is not technical language, but it is not poetry or analogy either; it is important to state that educators do not have a language for such internal awareness of load and learning, language to describe how we are aware of, how we sense the strength of memory schemas. "Vibration" is an informal word used to describe emotional states, how the atmosphere of a place or associations one may have with an object are communicated and felt by others. But "good vibrations" and "bad vibrations," mental and environmental were invariant constituents of awareness. Reconstruction of and reflection about CL produced real vibrations, in each instance, utterly independent of researcher awareness. Awareness of CL did not result in simplification, but amplification of cognitive processes and complex challenges. Experts may simplify techniques, but novices lived in the moment, were aware of the moment, and that the moment demanded deeper learning. It was astonishing to the researcher that although he had been the one to hold up the lens of CL to these novices in their practice, it was they who deepened awareness of their individual performances at a scale and level of detail he had never seen in years of training novices in this "simple" skill of circulating.

His own lack of awareness reminded the researcher of a passage from the Gospel of John, chapter nine, the end of the healing of the Man Blind from Birth.

> And Jesus said, "For judgment I came into this world, so that those who do not see may see, and that those who see may become blind." Those of the Pharisees [experts of the Law] who were with Him heard these things and said to Him, "We are not blind too, are we?" Jesus said to them, "If you were blind, you would have no sin; but since you say,

‘We see,’ your sin remains. (*New American Standard Bible*, The Gospel of John, 9: 39–41)

This blindness was not a matter of the researcher’s expert awareness compared to other experts’ awareness. Nor did lack of awareness result from a lack of expertise about novice practice; he has a profound understanding of the most recurrent practices and performs these, himself, automatically, and has coached these for years. It resulted from a fundamental difference between his expert awareness and novice awareness of recurrent practices. Because his expertise had already overcome CL in recurrent practices, he could only *look at* performances and resources, and was unable to *look through CL* at a performance or resource “in the moment” in the way novices did. He wondered if expertise itself confounds awareness of CL. It would seem only novices had direct access to this awareness and its profound directions, it only belonged to them at this particular career phase. This gulf between expert awareness and novice awareness was conferred by their novitiate itself, for only a new teacher could reconstruct “the moment” that belongs to them in a singular and unique way. The awareness-gulf was overcome through listening, and through helping novices attend to mental effort. Talking about mental effort required awareness of mental resources, performances, complexity, demanded a feel for cognitive processes and sensory information going on in individual minds; awareness of immediacy and availability of resources became awareness of learning levels and how learning design impacted these levels (as will be demonstrated in the data below). The conversation informed novices and the researcher.

The interview served as a tool for research and for learning by shifting attention, and the simple shift created awareness in novice teachers. An invariant constituent that arose from the anecdotal lived experiences of awareness was that novice awareness of their mental effort led to profound descriptions and evaluations of their own learning. How important is this finding? CL as a theoretical construct has a rigid set of definitions and concepts used to measure learning depth and efficiency of learning designs. Novice directions of awareness of CL while problem-solving and learning were more multiple and more profound than possible for an outside observer's, even an expert's awareness of that learning. The data regarding "How teachers became aware of mental effort" included all of these multiple directions, but all directions moved around their own learning process, the measure of their own learning, or how learning proceeded in the environment.

The Third Research Question

The third research question was, What do novice teachers experience as the consequences of different types of CL on their development of expertise? Consequences are both effects of mental effort, and the importance or relevance of that effort. Prereflective experiences expose the immediate effects, and the ways participants describe the meaning expose relevance and importance. The first section explored immediate effects, and this section will focus on the relevance and importance novices gave mental effort. Different types of CL must be treated phenomenologically, and refers to commonalities in the awareness of novices, the availability and immediacy of problem solutions or new learnings in the moment, or how environment impacted such availability and immediacy; for example, automaticity was found to be a sign of expertise, or full development of a performance, and overload was a sign of defects of mental resources, or the expressed need for more learning or better environmental conditions in which to learn. There are common characteristics of learning and problem-solving that result from mental effort, or "types." Development of expertise refers to a process of starting to experience something, in this case mastery of recurrent practices, experiences of real learning having happened. As has been indicated repeatedly, teachers striving for mastery of problem-solving and recurrent learnings were aware of the levels they had attained. They could judge where they were, and where they wanted to go.

The question presupposes that teachers experienced their own expertise or lack of expertise, that they were aware of a spectrum of learning development. Explorations of CL involved the most intense experiences of a teacher's day, but also the most common interactions within the life-world of the classroom; the experienced CL was not a meaningless chaos, but phenomenological interviewing allowed meaningful descriptions. The focus of interviews was always the novice teacher pursuit of teacher learning, their constant search for mental resources and performances in the moment. Learning was situated in the classroom by these teachers learning to teach and levels and types of CL that were perceived and described resulted in awareness of real learning and environmental conditions for learning (learning design). In the moment, the types and levels of CL experienced were relevant to how efficacious learning had been, and relevant to effective learning design. These are the main consequences of mental effort in learning given by teachers. This will be demonstrated.

Teacher experiences of mental effort (higher, lower, or overwhelming, inefficient or efficient) may result in various emotions, perceptions of self, and different impacts on students. In whatever way the feelings, time sense, exhaustion, euphoria, and student responses were described as immediate effects, in this section all of the elements of CL result in novice evaluations of learning and learning design. This was not a study of stress or emotions or how hard a job teachers feel they have, things that could be asked about at the end of a long day. Questions were posed in the context of learning new skills and finding solutions to problems in the complex classroom environment. It was a learning experience. "What was that like—?" led to the moment, to the performance, from the vantage point and awareness of mental effort within that moment. Because of this context, novice teachers very naturally explored learning effectiveness and learning design connections. To be clear, teachers described their real learning and problem-solving as consequences, and automaticity, overload and high CL as relevant and important to their experiences of learning.

In this exploration, teachers were able to describe a whole range of effects and results, many of which have already been described in the prior two research questions. While the first two sections of this research explored teacher descriptions of prereflective experiences to arrive at CL's essence and the awareness of the experience, this portion moves into the meaning of experiences, how teachers saw CL as it impacted their learning and their views of learning design.

Consequences are considered in several layers in this section. First, this section explores descriptions of the immediate results and effects on teacher learning. Automaticity led to judgments about the goals of learning to teach in a classroom, about levels of performance demanded. "Real learning" was described by novice teachers, and expertise. High levels of CL and overload led to judgements about learning, performances, and the environment. Skills labeled as "learned" about in university or "learned" programmatically (as information) were often described to be out of reach in classroom experiences where mental resources were tested and performances failed to materialize; after the conversation, these were no longer considered "learned." A deeper understanding of "learning" results from such conversations about fluctuations of CL. The question, "What happened when—?" led teachers to defects of learning or to blaming the environment of the classroom (the learning environment). Second, the researcher explores explicit and implied teacher beliefs about their own learning design, and how lived experiences and conversations about CL impacted these beliefs. This second part presents a powerful contrast to the first, and is necessary for a discussion of how teachers experience learning.

Immediate consequences. New awareness from their students, new emotions, a change in time sense, physiological changes, and, most importantly, awareness of their own real learning in the moment: all were immediate effects of CL described in the awareness section above.

Textural synthesis. In the sections on simultaneity, noticing, and automaticity, in the first research question, the characteristics of automaticity especially within simultaneous environments were explored and described by teachers. Teachers described automaticity as an activation of resources requiring minimal effort and that automated performances “just happened.” It was also indicated that new awareness of automaticity, reflections on automaticity, shifted the focus and goal of learning design for novice teachers to “real learning,” to the automation of performances. First, teachers associated expertise and mastery with a higher level of immediacy and availability of performances. Ivan Jentz called it instinct and related his own expertise in his career prior to teaching: “I’d know what to say, I’d know what was coming, I could read them [clients], I knew when I had to pivot because I’d—I mean, it’s that kind of thing you instinctually know.” Becoming an expert meant performances became instinctual: “I think you know [you are an expert]—yeah. I think when you just—yeah, when it becomes instinctual. When you’ve done something long enough and you realize you can manage a situation or preemptively manage a situation. . . .” Experts also could do things instantly, had instant knowledge, as Amanda Betz described: “Yeah, which hopefully will become just automatic and I’ll know it instantly. I mean, I feel like some teachers can tell by how they [noticed students] walk in the door if it’s going to be a good day or not.” Expert teachers had automated their recurrent practices, and it even was a source of Gina Hunt's critique: "That's the downside of, I think, [of an expert] becoming extremely automated is you're no longer picking things apart to that degree. Whereas a new teacher, because we have to, we're kind of going, 'What in the world?'"

More importantly, teachers had an expressed desire, in reconstructing the moment of CL, in directing awareness to their real learning, that mental resources for recurrent practices be immediate and available, especially when challenged with simultaneous complexity and the need for automaticity. They expressed desire to automate recurrent elements, such that learning, for them, meant to automate. In evaluating certain skills, teachers registered their level of automaticity, the degree to which they were natural or instinctual or could be instant in responses. They spoke of what "could be" but had "not yet" happened to their performances. Kevin Long lamented how "loud" he was and wanted to develop "the right tone for the right instances" (in the moment) and that this skill would become "natural" or automatic. It "could be" but was "not yet"; "Maybe something like that could become more automatic and flowy." "It's not automatic yet." "If it's not automatic, I feel like I'm a little—and my anxiety level rises because." This was *really* learning, Amanda Betz indicated: "That's really what I'm trying to figure out. Was this horrible, or could I refine it and it become automatic? Could it work in the future if we work out our kinks together?" Gina Hunt, describing the nonrecurrent skill of differentiation of instruction, wanted something that was automatic, and, in the moment, "quick, quick, quick:"

> You have a generic lesson that you're teaching, but this kid reads seven words per minute and this one reads 200 or whatever. And so when you send them off to independent work, you essentially need to have probably eight different menus for different ones to access. I wish I could do a little bit more of that automatically. . . . That quick tailoring that has to happen. So, you send them off in a group and all of a sudden you have to kind of tailor

> quick, quick, quick, quick, because this one can't do this and this one can't do this. And so the ability to quickly tailor independent work, huh, that's a skill.

Not only would specific skills, in the moment, be easier, her whole job would change due to automation of mental resources and performances.

> [My job] will get easier. And I think it will offset just like [financial credit] interest eventually does. I think that the benefits start to feel worth it. Even your pay is more liveable because things are more automated. You don't have as much stress. Yeah, I just think that eventually—and that's what gives me hope to keep going.

Even Catherine Doe's flat admission, "I don't do it [noticing positive student behaviors] automatically" was evaluative of her learning, since it was made in the context of reconstructing learning, her implementation of this skill in class for observation. The judgment, *this skill is not yet at the right level of CL* was also *this skill is not at the right level of learning* in all of these examples because these performances "could be" something that they were "not yet." They were expressing the hope they have for their learning, in each instance, as in this example from Amanda Betz: "And I'm hoping that, eventually, I'll be able to just kind of not stress about it as much and just do it, like you say, like it'll kind of be more automatic, but right now, I don't have cruise control yet. I'm still on the pedal. I'm still watching for all the obstacles. I don't have cruise control yet."

The detail of perceptions, again, in the context of describing problem-solving and learning, is noteworthy. Notice the following accounts of fluctuation. In these, high CL and automaticity were perceived during certain steps of a performance, as when Catherine Doe's automaticity suddenly happened in the middle of steps. "The most mental energy I give is trying to find a student that's doing the right thing, and then after that I know how to do it and it's automatic."

Or automaticity began a process, then it broke down for Kevin Long: "I think it's automatic up until I get to zero, and then at that point is where I'm having to think on my feet." Or Amanda Betz could describe a fluctuation that happened for a specific class: "I wouldn't call it automatic, but I don't think that I get bumped out of the flow as much as with that class." These teachers were diagnosing specific steps of a cognitive process, their performance, based on awareness of mental effort in the moments of enacting the steps of these skills.

When the hope was achieved, that is, when the "not yet" became realized, they were aware of a drop in mental effort. Teachers whose learning may have once been getting information or reflecting saw the goal of learning, the hope of learning, as automaticity, which Gina Hunt indicated: "So for me, now that I've wrapped my head around what I'm doing at reading groups, the second piece is that it's fully prepped and I can go on automatic now. . . . It's no longer a stick shift. It's automatic." Or Amanda Betz: "[T]hose definitely pull my attention to them. But if they're just minor things like side conversations, I feel I'm getting better at automatically doing it." Even though natural and automatic awareness might diminish, teachers would be aware *that* something happened, as Kevin Long said, "when I'm not having to worry about it anymore. . . when it just kind of comes naturally. And I don't even know if I would notice that, though. That's the hard thing. It's like would I really know that I've got it down because it's just going to be naturally." This lack of awareness was characteristic, but so was a recognition of fulfillment, when the skill itself had arrived, was complete, "it's just going to be naturally." The goal of real learning was to *not know*, in *this* moment, each step of what one was doing, to have to think each step but to still hit every step and pivot of a skill with great mastery. Because it had become automated, a skill seemed less relevant to Amanda Betz's learning, but only because the learning was known to have already happened: "I mean maybe that [skill] is not something super-important, but that's something that's been easier to automatically get in the hang of. . . ." Often, when asked about how they perceived their growing expertise or the changes over time in their mental effort, teachers included their enjoyment at seeing their level of mental effort change. Betz was talking about her learning the skill of noticing:

> I feel like I'm more perceptive now than even in the first couple of weeks of teaching. I don't think I was picking up on a quarter of the things that were really happening in my room because I was so self-focused, and nervous, and scared to be a teacher for the first time. And now, I feel like I'm a lot more calm as the teacher in the room. And so now, that lets me kind of use more of my attention span or my brain to be checking in with them. So I don't know. I do think it'll change, but maybe it'll just get more, not-over-whelming.

She presented how far she had come, and her hopes to go farther in reducing mental effort, in terms that reflect the results of automaticity. More attention span had been the result of learning, being able to use more of her brain to connect with students. She was aware of a change in mental structures, what using more of her brain allowed her to do. The effort was perceived as remaining, but her hope for a less overwhelming experience was established.

Some teachers sensed their mental space opening up due to automaticity, that their minds could do more, and hold more, when recurrent practices became automated. While increasing mental space is not usually treated as a relevant construct in current teacher learning design, teachers identified this space in the moment of cognitive processing. They could sense a kind of economy of mental resources being better managed in the moment, an opening space that resulted from learning processes.

They're just in this frenzy of trying to figure out what to do right just in this little circle around them. And then once that becomes kind of automated, "Oh wow. Oh, there's a deer on the shore, [laughter] and it might have been there a few days ago, but I didn't see it. But now I can see outside of that circle in a bigger radius."

Finn related this greater ability to see to her own automation of learning processes. Amanda Betz related what had happened once the recurrent practice of attendance became automated.

So I'm really doing [attendance procedures] automatically while listening. "Who is just putting off the warm-up? Who is actually doing the warm-up? Who hasn't even gotten out their notebook yet? Who am I going to have to ask about missing the test last week?" All those other things can go through my head instead of, okay, how do I pull up the role roster? There's more room for other stuff that is more important.

Other things could go through a teacher's head as more room for other performances opened up as a result of automating. Betz's attention to student responses in doing a new thingand her CL was higher, but this changed: "I was [more attentive] when I first started that thing, but once it became automatic, I don't think I'm quite as attentive, I don't think."

Based on the data, all teachers had developed their own automaticity, by themselves, in all cases; like automatic skills, the learning also "just happened" without experts helping it to automaticity. In terms of recurrent practices, their performances were observed and their feedback was information, strategies they were expected to introduce, and nonrecurrent skills were pushed and programmatically given. As will be indicated below, most teachers did not even request such automaticity from those involved in their training; their coaches had rarely focused on techniques, and never drilled novices in recurrent cognitive processes till automaticity was achieved. They had achieved it anyway, developing recurrent habits in the classroom arena over time. The data consistently indicated this, but one example of how awareness shifted goals and awareness of learning design stood out. Note how Gina Hunt responded to the researcher's suggestion that experts had helped her with her automaticity:

> Hunt: So for me, now that I've wrapped my head around what I'm doing at reading groups, the second piece is that it's fully prepped and I can go on automatic now.
>
> Interviewer: Okay. You go on automatic.
>
> Hunt: Mm-hmm. It's no longer a stick shift. It's on automatic.
>
> Interviewer: Yeah. Okay. And you've obviously seen another expert teacher doing it, and that helped. Okay.
>
> Hunt: I was really a little bit puzzled—the first few times I brought it up with my mentor, he just kept saying, "You just need to pull from these resources." And I was so bothered by that because I wanted to say to him, "This isn't clicking. This isn't automatic for me." In his mind, he's like, "Well, your fluency group— you need to just pull lines of— you need to do all these different things." And I'm thinking, "I don't have that bag of tricks built, so you keep telling me to do this thing that's not automatic yet." But to him, it was like, "Well, your accuracy group— pull out all your lines at practice. Or you can do this, or you can do that." And I'm thinking, "I don't have that, 'Or you can do this, or you can do that,' automatic thing yet." So I notice that even him as a mentor and expert teacher, he would still try to just teach that way. And I kept saying, "It's not clicking. I'm not there yet." So—
>
> Interviewer: Yeah. How'd that feel?

> Hunt: You almost don't want to speak up because you feel like, "Okay. He's explained it twice, three times, four times, and it's still not clicking." And you feel like it's expected to click, so you should either pretend that it's clicking and go work on it by yourself somewhere [laughter], by yourself, or you should just be honest and say, "Listen, it's not clicking yet." Or, "We need to build this bag of resources." But that was probably one of the examples that I really felt overwhelmed by, like, "Stop telling me that this should be automatic because it's not."

Again, the "bag of resources" needed to be built. The problem here was not the resources, but, again, the theme of their immediate availability, whether they really did "click" and could be drawn out from the bag instantly. She argued for what the researcher chooses to call "real learning," learning that goes beyond the giving of information. Repeatedly, novices testified they put their programmatic learning at a lower priority than the more recurrent practices, the performances needed for survival in the complex classroom. For Gina Hunt, that something was automatic indicated that it has been really learned. Such learning would be immediate and available in the moment, would "click" and the sign of this was in the level of CL, that it was automatic. The making of resources more immediately available in the cognitive process was a kind of learning teachers were not exposed to; but the demand was present. The shift occurred through a conversation and a greater awareness of cognitive load: Hunt was evaluating her learning design and designer in terms of whether the learning helped her manage her mental workload or not, whether the skills simply came, or required an ongoing conscious, clear reading of the recipe.

A different learning was given, a real learning, in each of the above anecdotes. Their learning "in the moment" had revealed the kind of learning they wanted "for the moment." Theoretical reasoning about simultaneous complexity or the CL construct did not take these teachers to this real learning. The contours and characteristics of this real learning were only known when "in the moment" mental resources and performances were automatic, or when they longed for or hoped for the automated performance, something really learned. The moment of automaticity resulted in judgement of performances as really learned. This shifted the goals of learning from merely getting information or reflecting to automating.

The same judgments were made regarding moments of high CL and overload. As described in the first section, teachers explained increases of mental effort and overwhelming cognitive processing as defects of learning. Defects of learning remains a complex concept. It was not the result of theoretical reasoning on performances, a researcher evaluation, but a result of an awareness within lived experiences that happened in the moment. It revolved around two invariant axes of teacher awareness. First, teachers were repeatedly made aware that a skill was not immediate or was unavailable to reach a goal or face a challenge in class. This was a judgment. The researcher does not make it. While he will suggest new learning design in the fifth chapter, the deficiency in performances was experienced by novices. Their response might not have been learned at all, it might not have been learned enough, but the absence of a learned performance was what was known. Second, they knew that in the process of doing the performance in the classroom, practicing it in the classroom, the overwhelming information and complexity made it impossible to cognitively process the performance, to practice it, to really learn it. The *intended* performance was a learned one, but the level of load from the complex classroom produced frustration and inability to change or achieve the skill.

All teachers described the difference between programmatic or university learning and having to learn the separate reality of the classroom. The classroom was a whole new world for all of them and the place and object of learning performances, how to process information, how to be aware and teach and engage all at the same time. Teachers often judged the moments of their learning based on the environment itself: the environment in which they were learning to teach often kept them from teaching. The judgment was demonstrated by Ella Finn. She was asked to reflect on complexity of information in the classroom, how much she had to mentally process, and reflectively compared her classroom teaching to what a nurse in an emergency room faces.

> Interviewer: Okay. So what's the consequence of the amount of information and the complexity that you just described? What are the consequences?
>
> Finn: The consequences?
>
> Interviewer: Yeah.
>
> Finn: Obviously, they're not as significant as those [nursing] situations. I think the consequences for the kids, which is probably my biggest concern, is that they may have moments of confusion, or feeling like they're lost, and a lack of clarity, and feeling like they wished it was easier for them. So that's probably my biggest concern, is that I'm not doing a good enough job and they're feeling lost. But, as far as for me, there's maybe the stress of feeling like I'm spinning, like I'm not really gaining and I'm not really assimilating that information.
>
> Interviewer: You're spinning?
>
> Finn: Spinning.
>
> Interviewer: Yeah. Okay.
>
> Finn: Yeah. I like that term. It's like you're just kind of spinning. It's like [inaudible], pivoting around and not really accomplishing anything.
>
> Interviewer: Yeah, we're back in the river. The raft is [laughter]—

Finn: I'm telling you, it's all very—

Interviewer: Life is a river [laughter].

Finn: It pretty much is. I can make an analogy for anything in a river. But, yeah. Just spinning around, just one oar, just going around in a circle, not making any headway. Sometimes I eddy out. I can't get out of the eddy, can't go down-river [laughter]. Yeah.

This was a description of her learning design, her "assimilation," of information, an evaluation of where she was learning, the classroom, at that moment of searching for solutions to problems and learned performances. Ella was in the river again, her favorite place, and her go-to description of her classroom learning. Her explanations had carried her down these rapids, the chaotic sources and levels of CL, downstream, to this place, the eddy. She only had one oar, perhaps the part of a performance? She was going nowhere. She was not assimilating information.

In the section on automaticity, "efficiency" and "effectiveness" were words used to describe practice. Some practices were efficient, done with minimal waste of effort, and some were effective, producing the desired results. But if efficiency of skills represented an awareness about use of resources to produce a desired effect, deficiency was also a powerful awareness. Examples of both classroom distractions as defects and the search for defective resources abounded, and were invariant constituents of teacher experience of CL; these were also interpreted by teachers as a lack of knowledge, or a lack of availability of knowledge. Heightened complexity within the classroom, extraneous distractions, resulted in teachers trying to see, to search for the resource, and teachers identified the results for learning from this. Kevin Long described his levels of load in terms strictly associated with classroom disruption:

That's probably where I've got to the point where I'm like, "You know what? Just forget it. Do whatever you want. I'll go sit at my desk." Like that's what I'm picturing as my

> mental limit. It's like, "You know what? I've tried to correct this or I've tried to have you guys listening to this instruction or whatever it is." And then it's just to the point where it's like I've done so much to try to get there and it's not happening to where I just kind of shut down. So yeah, I feel like that has happened a few times. And then it kind of takes you a while to kind of bounce back from that…

He went on to reconstruct just this experience. Then the researcher pushed into the meaning, which Long gave, a meaning that has to do with learning, his inability to grasp the resources and performances he needs:

> Interviewer: Okay. Well, what does that mean to you when you get overwhelmed like that?
>
> Long: That I don't know how to respond, like I don't know how to, how to deal with that situation, like I don't have the response or the tool, like we were talking about. Yeah. Like I don't have the answer to it.

While he experienced powerful distraction, he interpreted his failures in terms of not having the tool, the skill for which he was reaching. Like other teachers, he searched but was at a loss. He reached into his toolbox and found nothing there. Like the other participants, when asked the question about mental limits, when they had reached the limit of their capacity, Amanda Betz spoke of reaching the point of cognitive overload. She talked about all the things she could shove into her mental process, and then described how random, outside events pushed her, in a description of dynamic fluctuations in cognitive capacity:

> But most things, I feel like—the main things that I know that I have to do, I can shove all in there, and there's not really like a mental limit. But when there are random things that come up during the day when I'm already like working on all these other things teaching,

> I will forget them. So I feel like that's probably hitting the limit because it just didn't go in there and it didn't stay.

The last part of this description, getting the response "in there" and having it "stay" were a request for certain depth of learning. It could not get in there, because the classroom presented issues that had to be dealt with while the teacher attempted to enact new performances.

> Interviewer: Tell me about hitting the limit.
>
> Betz: I feel like hitting the limit is when I can't— I don't know. Like mentally exhausted and can't remember what I'm supposed to. I mean, I don't know if maybe when I blank out is a mental limit because I'm trying to do all these things simultaneously and teach at the same time, and it's just like "Whoa, too many things at once." But as far as overloading and hitting the limit, like I can't cram any more information in there, it happens.
>
> Interviewer: What's that mean to you when you feel that happening?
>
> Betz: I used to get frustrated. Now I just know that it happens to me, so I have accepted it.

Again, the two axes of awareness appeared, in that (a) she "can't remember what I'm supposed to do," and (b) "I'm trying to do all these things simultaneously and teach at the same time" or simply "Whoa! Too many things at once!" The moment of blanking out, reaching the mental limit brought awareness of her learning resource availability and environmental complexity. It is important to note that this was a description of learning, how her mind processed information in her learning environment, the classroom. She described the grasping for resources and performances there, even as she "crams" more into her mental processes, even as she dealt with multiple classroom goals. Then, at the end, when asked about the meaning, she talked about what the researcher considered a dramatic change: her natural response of frustration, an inability to change or achieve her goals, had given way to acceptance, the knowledge that this was what happened. Had the goal of learning fallen out of reach? What had she accepted? She has asserted that she was not be able to efficiently grasp these resources while in the classroom. The frustration, what might have served at one time as a relevant message, a sign, an indication that the classroom is a tough place to learn, for now, was just *what happened*. It was part of teaching, the learning experience of teaching. The distractions have become the set furniture of her classroom learning. The researcher wondered: what happened then, when the level of distraction and the lack of the resource just became part of the furniture? How did the teacher interpret her struggles at this point? Then the researcher noted another anecdote from Betz. She was talking about how she creates a culture of error in her class, where errors were accepted as part of the learning process, then applied this to her own teaching.

> And one of the things that I'm working on is to try to—celebrate sounds weird, but celebrate or acknowledge in a positive way mistakes or misconceptions. Because you have a ton of those in math class. And I did, and I still do. And I'm the teacher. So trying to make it okay and even encourage, like, "When you make mistakes, your brain is growing. Those synapses are firing and you're making progress!" versus. . . . "You just got four and that's the right answer." When you make a mistake, acknowledge it and fix it. You learn so much more from that. So I'm trying to remind myself of that when interruptions come up and if I don't know how to do [a performance], or if I responded too quickly and didn't fully answer, or didn't fully grasp what they were answering, or asking me. It's definitely helping my brain grow, but yeah.

The two axes of defects of learning were here as well, in the one sentence about reminding herself "when interruptions come up and if I don't know how to do [a performance]." She very naturally identified these two axes. Her response was to acknowledge her mistake, made in the moment, and fix it. Her brain would grow.

"Everything" is usually a pronoun referring to all things in a group or class; teacher use of this word, ongoing and constant, revealed a very specific intentionality for the novice teachers who used it to include all things involved "in the moment" of noticing, for example, or things to be learned in the first year of teaching. The pronoun had a commonplace, everyday usage, but also a usage specific to teaching, to classroom happenings, resources, performances. In the flow of teacher discourse, "everything" would seem to be outside of "the moment," a way of describing all of "the moments" together, but for novices, "everything" actually was shoved, repeatedly, into the moment, when the moment could not be encompassed, and, often, had to be used to truly express the moment. "Everything" being done in the moment was an invariant constituent in descriptions of overload, of the classroom as complex and in descriptions of learning; teachers used "everything" very often, to describe all elements of "the moments," what had to be seen in noticing, what had to be solved, learning and problem-solving that must be done, at once. Here is a sample from Amanda Betz, which resulted from being in the moment:

> "And so I'm really trying to keep eyes on those ones too in the back of everything that I'm doing."
>
> "Because you've got to keep an eye on everything and you can still be attentive to them at the same time."
>
> "and it just seems daunting because everything's new."
>
> "Because I'm the adult, I'm the teacher, and I need to know everything."

"so I feel like I should be able to remember everything, and so when I can't, it's frustrating."

When asked by the researcher, "Are there things you wish you could do automatically, things that you wish you could just flow through?" Betz responded, "Yeah. Everything. Yeah." In the 90 uses teachers made of this word, half of them contextualized and grouped classroom happenings (complexity) or learning. The researcher reflected that when teachers did not have the language to describe the complexity of the classroom, to technically discourse about the moment occurring with their multiple performances, "everything" was a go-to word, an easy pronoun for the moment that was packed with complexity, internal and external. "Everything" was part of the fabric of teaching. "Everything" kept coming up. This usage would not have been an invariant constituent except for several characteristic descriptions unique and singular to novice learning such as in this description from Gina Hunt:

> Because I feel like a good novice teacher is spreading herself as far as she can, touching as many areas as she can, beginning the work in as many areas as she can. And if she's touched all the areas, then she's got some knowledge about everything. And her job is to go around, and around, and around that area for enough years, until she starts sinking deeper into all of them.

Hunt had several descriptions of the "everything" that must be learned by novices, which will be explored later. She was aware of "everything" as a kind of weight of effort that sent her around and around and around. Catherine Doe went into more detail about "everything" within novice teaching:

> Doe: I think last year, it took longer for me to be able to do what I wanted to do because I needed to figure out how to do everything [laughter].

Interviewer: Tell me more about that.

Doe: I guess the first couple months, it was like, okay, I went to grad school. I did my student teaching. I did all this stuff. Now, I'm actually doing this by myself. I remember the first two months, I felt like, "Oh my gosh. I will never, ever not have something to do, because I need to get it all done right now." And so I remember trying to remember—the hardest part, I think, was having to read all the lessons I needed to teach. I couldn't do anything different than what was on the paper because I didn't have enough energy or knowledge to be able to change anything. But then I also wanted to do all this stuff with the kids, and the communication in the classroom, and last year, it was just hard to get that all done. And so I had to kind of focus on certain things and let go of certain things. And so I think the difference between last year and this year is I think this year, now I know what I'm teaching, and now I can focus on the environment more. And last year, I was more, "Let's figure out how to do it all together [laughter]."

Everything in these descriptions represents the wide fabric of cognitive load blanketing all learning. The moments of learning were dense with everything in them, and the learning of novices was dense with the moments. Everything is included because "everything" cannot be dismissed. These particular descriptions of everything in their environment and learning are a direct result of reflection on the lived experience of cognitive load.

Distractions in the environment and deficiencies in skill development were axes given by teachers describing their mental workload and learning. More examples are given here. When asked about the multiple tasks he had to perform while solving problems, and the impact of complexity while "learning on your feet" Kevin Long spoke of his efficiency or effectiveness, the “quality of learning.” While he had been talking about his learning efficiency, he contextualized this as “effectiveness across the board,” his teaching efficiency as well.

> I think that affects it as far as I’m doing all these things maybe at 75% of what I could be. Whereas, I could focus on something and have my full attention and my full energy into it but I feel like that kind of lowers my effectiveness across the board. I don’t know if that makes sense. I’m thinking of here’s all the tasks I’m doing but none of them are at 100% or the way I would like them to be done. So it’s like, yeah, I’m doing all these things but it’s kind of lowering that efficiency or effectiveness, I guess. Yeah.   Quality, it’s learning quality.

He wanted to “focus on something” and “have my full attention and my full energy into it”, but the distractions abounded. He was, as other teachers described in already given accounts, “spread out” in the complex simultaneity of the classroom and multitasking. He had an idea of how tasks should be done, “the way I would like them to be done,” but he could only do them at 75%. Again, a teacher was reaching for resources that he knew and was aware of repeatedly, and wanted to do these at 100%. Teacher effectiveness, the efficiency of learning, was impacted by, in his words, a lack of “efficient” mental effort. Like Gina Hunt, he had the recipe, the clear steps of the performance, but he was not doing it.

In the following description, Amanda Betz made clear that she did not lack the ability necessary to help her third period class; she was effective in all her other classes with the same lessons. But her third period changed her problem-solving capacity as she could not access the skills that were effective in other classes. Note her awareness of her flow, and her evaluations of what impacts and changes that flow and the learning.

Betz: Yeah. So that kind of throws me off the flow. I think just mass volume of so many people in here. My other classes are 30, 27, and 22, so I feel like a lot more manageable. And even when people are gone in here, I think just my mental-ness, just my mind is expecting—it comes to expect a rough period, which is bad, but in my head I'm like, "Okay. Third period." I don't do that for any of my other classes, but I kind of dread third period, because I just don't have a grip on them. I don't know.

Interviewer: Your radar's up a lot more?

Betz: Yeah. It's definitely up more, which pulls me away from the content. And I mean, I see it in their grades. I teach the same exact stuff every day and try really hard to keep them on the same pace, and on average, first period does 10 to 15 percent better on everything than them. And so that makes me feel guilty and bad. I don't know. However my brain changes and how I change the wording on things or whatever I'm doing, it's a mix between me and the kids, and it's just not quite working as well as it does in my other classes.

Again, there was what she called "a mix" that included brain changes, processes of wording things and doing, and the environmental complexity, all bound together in a singular assessment. She was analyzing, based on her learning environment, her problem-solving effectiveness and her ability to access her skills. While all descriptions of teacher learning "in the moment" included one or both axes, teachers also blamed themselves in a negative and, in the researcher's opinion, unhealthy manner. They indicated that there was something wrong with themselves when they encountered failure, as Amanda Betz hinted:

Interviewer: Okay. So what is the consequence of the amount of information and complexity on your learning?

> Betz: I feel like sometimes, I get too bogged down with making so many decisions in the meantime that it takes me away from my content with that. And then that's not good, and they don't get the best teacher they could have.

There was the acknowledgement of the two axes here. But she finished with a judgment on the teacher. While CL in the moment was always focused on immediacy and availability of resources, the failure of resources to present made teachers evaluate themselves negatively. Negative self-evaluation was an important phenomenon, as in this description from Gina Hunt.

> Interviewer: There's a lot to cover. Okay. What is the consequence of the amount of information and complexity on your own learning? I mean, you're trying to learn to be a teacher, and yet, all of this environmental—
>
> Hunt: Low self-esteem because you feel like you're failing. In those early years where you're building and you're spreading yourself so thin, you know at the end of the day, just like a car [loan's interest payment], that you haven't actually been paying for your car at all, you've been paying a banker, an interest payment. And so I think sometimes, at the end of the day, you're thinking to yourself, "Gosh, I'm exhausted! I've done all these things but yet, I did none of them well, because I was interrupted or because I was—because of all this noise and interference." And so I think that for a type A personality, which I think this job tends to attract, that sense of failure is really heavy because we don't like to fail. Type A people are very organized and scheduled and so much of this job—it's amazing to me that a type A person is attracted to it because this job has so many variables that you can't control.

The researcher did not interpret this type of self-doubt as an immediate result of CL. CL was not a measure of personal failure. As a vehicle of awareness it is always attached to a performance, in the moment, not to a personality. But some teachers, of their own choice, attached their performance to their person in the moment of high CL and overload. And no one experienced overload directly from classroom distraction like Ivan Jentz. He asked “What am I doing?” and it was not, the researcher immediately knew, a question about performance, but a question about his choice to help kids, the choice to be a teacher:

> Interviewer: You’re describing a really complex— a lot of information.
>
> Jentz: And then it gets— I try to think about it, but then it does become frustrating when you’re at that point where I felt like I was at times yesterday [his observation] where you can’t manage the ones that don’t want to learn. And you can’t teach the ones that do want to learn because this stuff is going down. And that’s when it gets frustrating to me because then you ask yourself, “What am I doing?”
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> Interviewer: Did you ask yourself that yesterday?
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> Jentz: No.
>
> Interviewer: But do you have—
>
> Interviewer: I don’t ask myself that much anymore because—that’s not true. There are days when I do. But it’s a dangerous question to ask yourself as a first-year teacher. You can’t go there. And I learned that. You try to go to places where you did do *something*. Anybody can live and talk about conflict in our—the brain’s hunger for it. Anybody can live in that conflict. . . . So yeah. I mean I know, and I’ve been there, where it’s like, “What am I doing?” But I don’t spend much time there. I mean, I’ll spend time thinking about how I can get to a kid, but I won’t spend time thinking about that.

This “What am I doing?” was specifically about teaching, a question of the decision to be a teacher which Jentz tried to avoid but which continued to insert itself because the learning environment, the environment for his learning, made his learning impossible. Again, however, the two axes are present and he was aware of them, the distraction which he had not been given the tools to overcome, and, in the last line, the focus of “thinking about how I can get to a kid,” the real performance, the not-yet known, that could happen from real learning. Gina Hunt also echoed this experience, but in response to a different question, the question of automaticity and how that would impact her life as a teacher:

> Interviewer: Well, what would it allow you to do if you were able to just automatically—?
>
> Hunt: I think it would allow me to enjoy my job more. I asked another teacher recently, I said, “What do you feel like when you wake up to go to work? Do you get excited?” And she said, “Well.” She goes, “Yeah, there’s days where I get up and I look forward to going to work.” And I said, “Are there ever days where you wake up and you’re dreading going to work?” And she kind of said, “Not really.” She said, “There’s days where I feel like it’s work. It’s time to get up and go to work.” And I remember thinking to myself, “Uh-oh. There’s days when I wake up and I’m dreading going to work.”
>
> Interviewer: Yeah?
>
> Hunt: Uh-huh. And I think that those are probably the days where I have the highest feeling of failure. Like, “Oh my gosh. That was just terrible. I don’t really want to get up and go fail again.” It just feels discouraging. And I would absolutely say there’s day[s] where I just go, “Why did I do this? Why did I choose this job?” This is a job that, in the begin-

> ning, you feel like you just cannot ever get there. Because you can't. And it's that interest thing again. You are stuck in this zone your first few years, where that lack of mastery is sad and depressing. And for me, I'm in a financial plan this year where I have these goals that I'm trying to meet. But I thought it would be a little more invigorating to just watch your debt go down. It's invigorating for a day. And then you have to wait 29 more days till payday to watch it go down again. And so I think I underestimated. I was hoping that—going after this aggressive financial plan—I hoped that that feeling of getting somewhere would last longer. So I think with teaching, when you have those good days, if it's offset by too many hard days, the product, you just feel like, "Man." It's not a great feeling.

What was startling was she "cannot ever get there" in her job, she could not learn. She described this as a fact of the "beginning" of teaching, of novice teaching. Her other accounts (several below) made this stymied learning an issue of real learning, "deeper" learning as she often described it, of gaining automaticity. After focusing on awareness of CL, Gina Hunt in particular described frustration in her search for automaticity by experts who only went so far, only conveyed surface information. The researcher reflected that her intense and brutal judgment of her life as a teacher was actually a massive indictment of learning design. Teachers had to develop real learning, deep learning in their classrooms, the only place of practice. The researcher had attempted to ask her a question about automating a performance, and she rushed into her hope: that it would make her job easier. She had not departed from the double axes of explanation of overload but had explained how real learning would transform her job.

Beliefs about learning and learning design. Teacher beliefs became an emergent theme during analysis, which could not be ignored. In recent years, teacher beliefs and how these impact teacher behaviors have become important in education studies. What are beliefs? Dewey (1933) distinguished knowledge from belief and maintained that belief "covers all the matters of which we have no sure knowledge and yet which we are sufficiently confident of to act upon and also the matters that we now accept as certainly true, as knowledge, but which nevertheless may be questioned in the future" (p. 6). Beliefs are acted upon as sure knowledge until they are overthrown. Bandura (1986) contended that beliefs indicate choices and behaviors that people engage in throughout their lives. Brown and Cooney (1982) claimed that beliefs are dispositions to action and behavior. For example, teachers who hold certain beliefs about Title I students will make choices about their learning and teach them in a certain way. Pajares (1992) documented a variety of beliefs specific to teachers which included teacher beliefs about epistemology, self-efficacy, the causes of teacher and student performances, beliefs based on attributions, locus of control, motivation, and teachers' self-concept. One element of teacher beliefs that will be important for this research is how beliefs remain stable and continuous, how they are hard to change even in the face of researched practices and proven data of teaching; the beliefs that teachers hold are stable, and this is true over the passage of a single year (Stipek, Givvin, Salmon, & MacGyvers, 2001) and even over an entire career in teaching (Tschannen-Moran & Woolfolk Hoy, 2007). The literature cited indicates beliefs have relevance to teacher behaviors regarding their own learning, and novice teacher beliefs may indicate life-long directions for learning that will either liberate or frustrate them.

Participants expressed powerful beliefs about becoming experts, how learning best happened for them, and beliefs about their design of learning. Moreover, beliefs revolved around the navigation of complexity; given resources available and the challenge of acquiring complex performances within this hugely complex environment, and the learning design promoted for them, teachers developed these beliefs. “Time and experience,” with “trial and error” within this complexity helped one navigate to expertise. When asked about how the complex classroom, their place of learning, helped them, beliefs offered road-maps to them through deficiencies to new efficiencies, meaningful ways to describe what was happening as they practiced and grew. The anecdotes were identified as beliefs because what was given as knowledge or wisdom from the road map was at times in conflict with the teacher’s own awareness and lived-through experiences, as will be indicated in anecdotes. This section explores the consequences of types of CL, how awareness of automaticity and awareness of learning deficiencies due to distraction and lack of skill availability impacted these belief road-maps. Teachers with strong beliefs about their learning had new awareness result from lived experiences of cognitive load. What were the consequences for beliefs brought about by new awareness about learning and learning design?

The following anecdote serves as a good introduction to the beliefs of teachers and the sometimes conflicted nature of these belief. Teachers shared many consistent beliefs about their learning, how they learned best. They had beliefs about how teachers became experts, about sources of learning, and described both elements of lived experience and theoretical frameworks. Amanda Betz summarized her beliefs about her own learning in the following exchange:

> Interviewer: How do you get there? How does it become easier? I mean, as you look forward and you’re thinking about your own learning, how do you get to be that person [the expert]?
>
> Betz: I think you[‘ve] got to persevere. I mean you[‘ve] got to have the experience, and if you don’t persevere and go through it time and time again, you’re not going to get the experience. I think that reflection is really important. I think I maybe mentioned I started journaling at home once I became the legitimate teacher, the only one in the room, so not

> student teaching. And that has helped me. So, I feel like with experience in the next five years and constantly reflecting and finagling things, and refining them, and talking with other colleagues, I think that would get me on the right path. Collaboration with other teachers is something that I really value as a new teacher, and I'm sure I will always. And as far as what's going through my mind, there are multiple times every day where I'm like, "I should ask so and so about that," just because—I don't know—I'm pretty comfortable; I'm very comfortable with asking other people for help. I don't want to solely rely on someone else, but if they have tools that they don't mind sharing with me, then I'll take up. So collaboration, reflection, and experience.

There were many belief assertions here. She led with "perseverance," which is maintaining a course of action even in the face of difficulties. Experience had two nuances here, that other teachers also described. "Experience" sometimes refered to a practical contact with facts and events, with the reality of the classroom. In this experience, the classroom is teacher, as when teachers asserted that experience (being in class) was a better teacher that University. But with the emphasis on time and perseverance another type of experience emerged. Experience was what resulted when one went through "it" time and time again, where "it" was undergone to produce experience, a thing one "gets" over time. The "it" one went through appears to be teaching in the classroom, undergoing the complexity of environment and thinking, regarding which Betz had said, "That is teaching." Here, her belief matches that of other teachers (which will be analyzed below) who also adamantly and explicitly asserted "time and experience" together, that something must be undergone over time, experiences, to produce experience. Novices, as will be shown, considered time, the months and years required, the necessary time, a fact of gaining "teacher experience." It was a fact that all teachers had come to accept, and the months and years of effort could not be avoided. Even though experience at rare times referred to a result of the moment, a practical contact with classrooms in practice, the view of it as a mass accumulation belonged to all teachers. Time and experience were almost always together in this way, the former giving the latter, a construct of two concepts bound together, and were given together by all teachers, that years gave comfort and competency, experience. The long journey to performances, which were created and discovered in the classroom, had shaped this emphasis; real learning occurred over years because it took years. The "experienced teacher" has had the classroom happen to her or him over time, it was a sum result of time within this complexity, the result of perseverance, a status acquired by doing "it" for awhile.

Reflection was really important for Betz (and Doe), and journaling at home had become really important when she was, interestingly, "the only one in the room" where teaching in class happened. While several teachers questioned the relevancy of reflection, Betz herself practiced this on her own, and the subject of reflection appeared to be her teaching in the classroom, what she was undergoing. Her startling introspection throughout the interviews indicated a high level of skill in this practice for the researcher. As she navigated the complexity described by her throughout all the interviews, she stopped to reflect. As she said at the end, "collaboration, reflection and experience" were the trinity in which she believed. Reflection came with "finagling things" and "refining them" and with conversations with other teachers, and these would get her on the right path. Betz often used the word "try" to describe her implementations of advice. Trial and error, finagling and refining, was a bedrock belief of all teachers, as will be shown, and was supported by feedback and collaboration. Information had to be tested in the classroom, time and time again, on one's own, as one went through "it." In the midst of time and experience, the trial of new things was always there. Being alone for classroom interactions was also reiterated by teachers; coaches and other teachers would provide information and advice and help with observation, feedback and reflection but going through "it" was solitary. Very often among teachers the resources were described as exciting and acknowledged as expert practice, but the resources did not receive priority, could be put on the "back burner" because teaching in the classroom demanded different learnings, as will be analyzed in the fifth chapter.

There was a small pivot, however, toward the end of the above anecdote, when Betz said, "And as far as what's going through my mind, there are multiple times every day where I'm like, 'I should ask so and so about that,' just because—I don't know—." There were two awarenesses in this pivot. *What was going through her mind* had been the unique and singular subject of the interviews, an interior turn to cognitive processes, what we had been talking about. She then described "multiple times every day," the moments she realized defects of knowledge or performances and a need to ask about specific teaching performances of others; these were not merely multiple times of confusion or exhaustion, but moments where she turned to experienced teachers for advice "about *that*." The real learning needs indicated to her by "what's going through my mind" and "multiple times every day where" during the moments of class led her outside, to other teachers, to experts for help, and she was comfortable with outside information. Other teachers also believed in their own version of expertise transfer, and actively sought it after moments of awareness of struggle. They turned to teachers who had been through it over time, experienced teachers, for tips. It should be noted that this belief was not the same as that expertise transfer within cognitive psychology. Cognitive psychology models of learning as "expertise transfer" are entirely different from information given by other teachers and reflected upon; in expertise transfer, recurrent practices become automated performances through processes of building long-term memory schemas, "chunking" large and complex cognitive processes.

Teachers considered the classroom itself a teacher, and the method was trial and error. Catherine Doe, throughout her interviews, firmly held to this belief in the classroom and the process.

> Interviewer: What is that like though? I mean, it's got to be very complex at times with so many different things to learn and so many—
>
> Doe: I think I take it—kind of fun, because I want to see what's going to happen. And I think more about—it takes me a while to figure out what to do, but I learn what to do and the kids learn and—I don't know. It's more just trial and error.

In reflecting more deeply on her first months of learning, Catherine was positive about the experience.

> I was positive about it. I like to learn a lot and I like to learn from my mistakes until—I was stressed out because it was all new, but at the same time I knew I was learning from it. So I was still positive about it.

However, contradictions emerged between beliefs and lived experience for teachers. Sometimes implementing a new practice, trial, just added to the stress of teaching, "added to the list," as was the case with Kevin Long. Other teachers indicated some advice was like this, another unfamiliar performance that was a greater "load" in the classroom. Interestingly, Long described how implementation of a new practice in the classroom, the trial of new things in its complexity, did not help him, but then affirmed his belief that trial and error were what helped his learning.

> Long: Yeah. It's just one more thing to add on to the list. Not only am I trying to deal with all these things but now I have something that I don't even know really what I'm doing or how it's going to turn out. So yeah, it just adds to the stress, I think.
>
> Interviewer: But that helps your learning, you say?

> Long: I don't know if that helps my learning. I think kind of that trial and error is what helps my learning, like try it out, okay. It didn't work. So let's bag that idea. Try it out. Okay. That was pretty successful. Okay. We'll try that again another time. We'll try that again with the next classroom. So yeah, I don't think it's really the load that's helping my learning. I think it's just trial and error that is helping the learning. Yeah.

His initial awareness, from lived experience in the classroom, was that trial of new things in his complex class did not help his learning, and then, when the researcher tried to clarify, that he did not know if such trials helped. He had a new performance to integrate "that I don't even know really what I'm doing or how it's going to turn out." He had been moved into awareness of classroom complexity, where his trial of the performance added to the complex of daily problem-solving. Then, suddenly, he adamantly affirmed his belief, that it was in fact trial and error that helped his learning. He did not seem aware of the conflict in his discourse, that is, that he had been talking about the same thing. He had moved from lived experience to belief, gave one description and then fell into what seemed like a mantra, his faith statement. His last two complete sentences summarized and reaffirmed the separateness. The "load" (from trial of performances within complex distractions) did not help his learning, then the contrary belief that trial and error in the classroom helped. Long also described how advice from other teachers was integrated into the trial and error process.

> I think [trial and error]'s a big one. Talking to other teachers. When we have our prep time to meet with others, we always are bouncing ideas off each other and, "What do you do here," and, "What do you do when this kid does that?" But yeah, I think a lot of it is just kind of that same throw it at the wall and see what sticks [laughter] kind of thing. So far, I mean, that's kind of where I've—I don't know.

Experienced teachers were present, could be asked, “What do you do?” but what was given then went through the “trial and error” process in the classroom, throwing the learning at the wall, and watching to see if it stuck. He believed that one must take advice, throw the suggested performances at the wall, in order to “see what sticks.” Interestingly, this statement of belief was followed by the last sentence, a confounded reflection on the kind of knowledge he just gave. The last sentence seemed indicative of the kind of knowledge belief can become; “so far [in my experience?] that is kind of where I’ve [gone in my learning?]” followed by “I don’t know.”

Ivan Jentz believed in the same type of trial process. He had asked and received the advice of other teachers and tried what they had told him to do. But he also affirmed his belief in time and experience.

> Yeah. But I know what it feels like to look at somebody like the expert [. . .] that comes in. And [you say], “I know. I hope someday I’m like that.” Right now, I’m not. And when you’re not there, and you know that it’s really just time and experience that gets you there, right? Then you don’t see yourself there until you’re there. Do you know what I mean? I’m definitely not there. Because I don’t have—it’s everything that comes with experience. Confidence, been there done that. This is something you have a knowledge of, how you manage something with prior experience, whatever. You learn from that. And you bring that back if it happens again. So yeah. I will get there.

Again, “time and experience” here were a vehicle, what gets one there. If the teacher learned from time and experience, “someday” he would arrive at expertise. He would not be aware of expertise, would not see himself *there*, until he *was* there. He claimed that he was aware that he was “definitely not there,” but this awareness comes from not having “everything that comes with experience," that "been there done that" confidence. The "knowledge" accumulates as experiences happen over time; as experienced situations happen again, one pulls from the prior happenings of classroom situations.

"Five years" was an assertion in some teacher beliefs. Time was always a factor in all teacher beliefs about learning. "So, if I had five years of experience of that curriculum, I would know—" Of a teaching practice irrelevant for a novice, Ella Finn said, "that piece would be great five years from now for me. But for me right now, I felt that's the piece that, after I'm not swimming over my head anymore, I could use." And Gina Hunt: "It's almost like the goal in the first five years is to spread yourself over as many things as you can to have a little bit of information about many things." Gina Hunt used the image of novice teacher learning as like a "high interest loan," and the researcher asked,

> Interviewer: You mentioned a couple of times, "Five years." Were you thinking of your car loan or were you thinking of teaching?
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> Hunt: Teaching.
>
> Interviewer: You were thinking of teaching, that after five years you get it?
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> Hunt: I think you're either in or you're out at that point. And I think that after you've done a couple of trips around the sun, you know what you're doing, you know if it's going to be a good fit. And I think that if you quit, it's probably within that time frame.

"Five years" was not something these teachers had gone through, but represented beliefs about what must be undergone. Persevering through five years of trial and error meant that a quantity of experience would be achieved, that expertise would happen. When asked about whether the classroom, her learning environment, was helping her, Gina Hunt had spoken of novice teacher learning with the analogy of the interest loan:

> Ultimately, I think that it's helping you. But similar to a high-interest loan, the first part of it you spend—most of your stuff goes to the interest payment. So sometimes, with the classroom, it feels like you're investing more in that interest payment than in the principal itself. Because there is so much learning that's happening. So that's kind of what it reminds me of, I guess. . . . I think because there is so much learning that happens in the beginning, it doesn't feel like it you're making as much headway on mastering because you're spread so thin across so many things. It's almost like the goal in the first five years is to spread yourself over as many things as you can to have a little bit of information about many things. And then after you cover that ground, you get to start going deeper. So similar to even a car loan, it's like your first year or so you're really hitting the interest, and then you finally start accessing that principal. So I feel like every week you've got something new, so you've got something else to spread yourself across, and it prevents you from that deep feeling.

Again, the time and the experience, the perseverance through difficulty were evoked in this image. The image of paying off the interest and not the principal, of persevering through, and, again, "five years" of teaching, was a negative image of the interest payment, of a time when the payment did not reduce the debt, where there was really no sense of gaining ground. Every week there was "something new" or "something else to spread yourself across" (her image in other anecdotes as well, what complexity of the classroom did to her) and the somethings prevented one from *deep* feeling, the moment one started "going deeper." Was experience the same thing as deep learning, real learning, in this account? It could not be, since such deep learning would only happen after a certain time, after the interest portion of a loan was paid; after one had five years and experience, one goes deeper. The things that spread one out seemed to compose experience. Teaching was the payment, the resources brought to bear paid for experience. The classroom taught the teacher, in the first five years, gave something new, something else to spread a person, gave a little information about many things, to pay the interest.

"Experience" was also trial of new practice within a classroom, and the "best teacher." Gina Hunt asserted that this kind of learning, from what happened in the classroom, was better than programmatic learning: "I think to answer your question, experience is your best teacher. So I think the sad thing about being a novice teacher is so much of what you learn in school to become a teacher is so not reality when you actually get there." Experience, practical contact with students and classroom practices could teach one, and it was also most often an accumulation of experiences that was perseverance. Trial in a classroom was experience, and multiple experiences produced experience. When Catherine Doe was asked about how she would design learning for a new teacher, she gave this advice, emphasizing trial in the classroom as answering the needs of new teachers.

> I'd let them teach by themselves. I think the best advice [Name redacted] actually gave me the first month I started here was, you can't do it all in one day. And so I think the best advice for a new teacher is just to go in there and try it, and you're going to fail and it's going to happen because I know I did. And so just to roll with it and to go, "This isn't going to work, but this might work." The most I've learned is from just experiencing it, and having experienced it in the classroom. I think for a new teacher, that's what they need. Is to just be in the classroom by themselves and then have the support system that they need to reflect on.

Her description summarized all of the beliefs explored thus far. Teachers learn best on their own. It takes time, one cannot do it all in one day. The best advice was to “try it,” and error was going to happen but one must roll with it, persevere. She said that the most she had learned came from experiencing, practical contact with teaching, and then clarified that she had learned in the classroom, which was probably why novices must “be in the classroom by themselves.” The role of the support system was to reflect on this experience with novices. She enjoyed getting feedback and being observed, she had said earlier. In the last words of Doe’s third interview, she asserted once again her belief in trial and error: “I like to think about the first half of the day and then the second half of the day. If in the first half I failed, it’s fine. I’ll try again in the second half. And then if that failed, I got a whole new day the next day [laughter].”

What was “experience” for teachers? While Doe referred above to experiencing and experiences to describe classroom happenings from which she learned, “experience” was used by participants mostly to describe an accumulation of knowledge directly related to classroom interactions over time. Trial and error referred to attempted performances, while time in class, interacting with students, doing these performances produced experience. All participants often expressed admiration for the experienced teachers, specifically, teachers who had done their time in the classroom. It was interesting to note that questions about expertise, growing expertise, led to descriptions of experience, even though the two do not seem to equate. Teachers described other experienced teachers as having a certain quantity of interactions, and described their experience in terms of time, and that was why “time and experience” were used invariably together. These teachers were believed to have answers, performances and processes because of time in classrooms. Whether this time should be associated with proven learning was questionable, as teachers often questioned the practicality of information. Ivan Jentz described an experience that many teachers seemed to depend upon: the experience of other teachers.

> Jentz: But I was having these challenges, and I went to him [a veteran teacher] one day, and I said, “Here’s what’s happening, and I don’t know what to do. And I don’t want to be this person who they’re going to hate because I’m mean. But I need to manage them.” And he said, “It sounds to me like you need to start sacrificing some of these kids to the Gods of Class Management. Make an example out of a couple of them. And then they’ll know you mean business. The kids you sacrifice, they’ll come back. They have it coming anyway. They’re doing it on purpose.” You’re [the veteran teacher] looking at something from 12,000 feet now, when I’m down literally, under the trench. And he’s looking at it from up here. So—
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> Interviewer: Up here, you mean from his experience and—?
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> Jentz: Yeah. He’s able to—
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> Interviewer: He just does it?
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> Jentz: Yeah. Yeah. It’s like anything. It’s clearer to him because he’s seen it, most of it, if not all of it. He’s been in the same school for X years, teaching the same grade, same subject, point in time. You’ve seen it all, he’s seen it all. So yeah. He’ll say, “You’re in the trench—but I’m going to tell you what I can see from 12,000 feet. This is what you should do.”
>
> Interviewer: “Sacrifice them to the Gods of Classroom [laughter]—”
>
> Jentz: Gods of the Classroom Management, right?
>
> Interviewer: I’ve never heard that phrase before.

While the researcher had seen this particular "religious" ritual performed over the years, even by experienced teachers, it was usually as a last resort. It seemed less a classroom management technique than a way to reduce complexity by removing students from class. But in this anecdote, Jentz demonstrated how far belief could take him. He believed in the "experience" possessed by the veteran teacher, the height he had achieved, and he gave the reasons: the veteran had seen it, done it, probably all of it, and been in the same school and same subject for years. The "sacrifice to the gods of classroom management" seemed, to Jentz, experienced teacher practice, a performance he himself could not have seen down in the trench of inexperience (Ella Finn's small circle of vision?).

While teachers held to beliefs about time and experience, trial and error, they also complained about them. Hunt was asked about expertise and at first described motherhood, her automatic knowledge. The researcher came back at the question and wanted a specific focus on teaching, and this time a positive description emerged based on her belief:

> Interview: Okay. So how do you get there? How do you get to become an expert teacher? You can see yourself as—you kind of dodged my question in a way, because you talked about being an expert mom covering for it. I mean, in terms of being, becoming the expert teacher, or the experienced teacher in the story.
>
> Hunt: I think the only way through that, the only way to access that accolade is to be—it's time. It requires time. So until you get that interest paid off, you're not mastering. You're not a master.
>
> Interviewer: So you have to get all the interest paid off, and then you can start working on—

> Hunt: Mastery of anything. . . . Because I feel like a good novice teacher is spreading herself as far as she can, touching as many areas as she can, beginning the work in as many areas as she can. And if she's touched all the areas, then she's got some knowledge about everything. And her job is to go around, and around, and around that area for enough years, until she starts sinking deeper into all of them.

Time, once again, was believed to be "only way" to expertise. One may notice the last statement, however. Teacher learning was described as exposition to everything at the same time, "the interest payment," and this was contrasted with the deeper learning, "the principle" she described as happening only after years of work. "Mastery of anything" happened only after the interest was paid. One went "around and around and around," like Ella Finn's boat with one paddle, caught in the eddy, over the surface, and then started to sink deeper, after enough years. One has to go around the sun several times as well, Hunt claimed, to know if teaching was the right fit. She had the belief, but classroom complexity created conflicts with her. Catherine Doe (also a second-year teacher) described her first year of teaching in similar terms to Gina Hunt, being spread out:

> I think last year, it took longer for me to be able to do what I wanted to do because I needed to figure out how to do everything [laughter]. . . . I guess the first couple months, it was like, okay, I went to grad school. I did my student teaching. I did all this stuff. Now, I'm actually doing this by myself. I remember the first two months, I felt like, "Oh my gosh. I will never, ever not have something to do, because I need to get it all done right now." I remember trying to remember—the hardest part, I think, was having to read all the lessons I needed to teach. I couldn't do anything different than what was on the paper because I didn't have enough energy or knowledge to be able to change anything.

> But then I also wanted to do all this stuff with the kids, and the communication in the classroom, and last year, it was just hard to get that all done. I had to kind of focus on certain things and let go of certain things. I think the difference between last year and this year is I think this year, now I know what I'm teaching, and now I can focus on the environment more. And last year, I was more, "Let's figure out how to do it all together [laughter]."

Performances had to happen, even though the learning had not yet happened. Perseverance, pushing through a skill's absence, was again the key. Also, in both Hunt's and Doe's account, there was the shadow of "everything," the need to "figure out how to do it all together." Both of these teachers spoke of having to learn everything, deal with everything. The researcher reflected, if one was an expert and had automated recurrent practices or could habitually meet goals and solve problems without a lot of effort then "everything" was less a problem; novice teachers were troubled by the "everything" that was there and discovered their limits. If one went through five years of teachering, persevered, one could not help but automate a great deal of things, and things would become easier. "Learning everything" was the object of perseverance, the "experience" gone through in the classroom, doing "everything." Having to do it all meant also to learn it all, to mentally process it all, spreading the teacher out. Moreover, in "everything," it was implied that no performance was distinguished from another or given an order in training or in programmatic learning, but everything was "all done right now." Among everything, Doe said, "I had to kind of focus on certain things and let go of certain things," because the teacher had to create her own order and priority. The researcher reflected that when recurrent performances are not distinguished and automated the result is that everything, nonrecurrent and recurrent, must be done, learned, performed at once.

The researcher searched for the word "try" in the 18 interviews on Atlas.ti, and was startled by the usage of this word. It appeared just over 350 times in the interviews. At times it was applied to student activities, and the Interviewer utilized it infrequently, but for the most part it was used by novice teachers to describe their learning, a go-to verb for solving recurrent problems or working on a new practice in the moment. All areas of new practice, including "trying to think" about certain performances, are tried. When teachers sought to describe what they were doing, it was almost always what they were trying. Perhaps this is not significant. But the researcher also thought of expert descriptions of their own practices, recurrent practices or solutions to endemic problems; is there a point at which teachers no longer try to do certain things, when, in the moment, they simply do them? When one is no longer making attempts or efforts to do something, to exert oneself, or, in the simplest of expressions, trying to do something, or when the cognitive load disappears from performances, the expert teacher no longer tries performances; what is no longer trial is also recognized as effective. Trial, the effort to accomplish something, may disappear.

However, some teachers in their beliefs seemed to stand against the above conclusion. Some believed that trial was always there, and would never cease. That classrooms were a place of interactions creating "experience" was an ongoing belief of teachers. But some teachers questioned that there could be a finished product in learning. In the following anecdote, Jentz went into more detail about the process of "experience" and his beliefs. Although Jentz was describing performance acquisition, his learning was a kind of autopoiesis, a self-creation process of the teacher attempting to function in the classroom. He was asked how he knew he had learned a performance, how he became aware that he had "nailed it." His claim was that this could not be known. He blended time and experience with trial and error to describe a creative process that negated every performance, where positive judgment of performance was just “fooling oneself.” It was the process of ongoing creation that mattered most in his belief.

> Jentz: I think it’s like an artist or a musician or any. . . . My daughter, she’s in art school. She just graduated from art school. And I have a little bit of experience in things similar. And I would say to her—so she would do a piece, something, a painting, whatever, and she would show it to me. But in the meantime she will have moved on to something else, whether it’s a week or two weeks or a month later or whatever, and you say, “Hey, I love this thing you did last month!” And she would say, “Oh my God, throw that painting away! It sucks.” Because she is on to something else now and she has grown. So everything I’m telling you right now—where I think these things are like little wins, that I’m doing things pretty good—I’ll look back in a year and if you happen to have me on videotape, I will say, “Throw that thing out! That guy sucks.”
>
> Interviewer: That guy sucks?
>
> Interviewer: Or if you’re a musician and you’re playing something and you say, “I like this, this is good. I think we’ve got something going here.” Then you move on and you listen to it again a month or two months later and you say, “I am so much better now! That sucks!” I think it’s that kind of thing in a way. In order to grow, you have to fool yourself a little bit.
>
> Interviewer: You have to what?
>
> Jentz: You have to fool yourself. And for me, at least, that’s. . . . I’m programmed—
>
> Interviewer: What does that mean you have to fool yourself?
>
> Jentz: It means you say what keeps you going. You say, “What I did today was good.” And maybe it was. But if you’re asking me, “How do you know when you nailed it?” I

> don't think you ever do. Because I'm gonna look back on whatever I did today, what I thought was really good—and maybe today I thought I nailed it, or I'll look back on something I did a month ago that I thought I nailed and say, "Not really." But that's the beauty of it in the moment you're in, you think you nailed something, and that's what you need to keep you going.
>
> Interviewer: You fake it till you make it?
>
> Jentz: Yeah there you go. You fake it till you make it. Listen, there are days when you do it and it sucks. I'm not saying all the time you tell yourself you nailed it. But if the question is how do you know when you nailed it, well, your mind tells you that because you need to know that, to think that sometimes. Does that make sense?

Expert performance, a finished technique, was considered an illusion here. The researcher recalled Ivan Jentz in the moment of overload, during the "magic stopwatch," that when he could not have a mental process at all he wanted to be in a place where he could "formulate a plan," or create the solution. He had an artist's approach to practice, a musician's view, and the final product was never complete. The researcher was aware of solutions to the problems Jentz, in his lived experiences, was searching and grasping toward, techniques that could and would turn his classroom around, if practiced, and that the steps of these practices could be trained to automaticity; this awareness that responses to these problems do not need to be created is not theoretical bias, but knowledge of expert practice. The belief in creative process that resisted a finalized expert performance was not isolated. Catherine Doe was also a devotee of her own experience. Note how adamantly she asserted, in this anecdote, that "no teacher is an expert." Also note her belief in teacher learning was based on her belief about the classroom, that all classrooms were different from each other.

> Doe: Yeah. I don't like the word "expert" because no teacher is an expert, I don't think. Every teacher is learning all the time no matter what they're doing because not every class is the same. So I think there's experienced teachers and then there's novice teachers—and then there's expert teachers.
>
> Interviewer: All right. How do you get there?
>
> Doe: Practice.
>
> Interviewer: So how will you know that you are the expert?
>
> Doe: Well, I'll never be the expert. I don't like that word.
>
> Interviewer: Or the experienced teacher? How do you know that you will be the experienced teacher?
>
> Doe: When I don't have to think about how to react to all of the situations. Now I know the kids enough in this class where I can say I'm experienced with this group of kids but not with all the scenarios that might happen.

In many accounts, Doe described practice as trial and error with feedback and reflection, a process of creation that she had adamantly insisted should be done alone in the classroom. That was her learning design for novice teachers. Experienced teachers helped to reflect on this practice. She would never be the expert, only more experienced, a person who learns through time and practice. The classroom creates this belief, because "not every class is the same" and one must "know the kids enough in this class where I can say I'm experienced" but within that classroom one cannot become experienced with "all the scenarios that might happen." Endemic problems, recurrent "scenarios" were not emphasized, and in other accounts of Doe she indicated that the singularity and uniqueness of each student in every class demands a special teacher with special performances; "everything" appears to be nonrecurrent here. That every class was different, in the above anecdote, meant "Every teacher is learning all the time no matter what they're doing." There was no final, perfected performance. However, her pivot to automaticity stands out in this belief statement: she will be the "experienced teacher" when she no longer has "to think about how to react to all of the situations." There was a contradiction here between belief and what she described in reconstructions of her CL. If every teacher is always learning, she would never be the expert, for there are no experts, but there also would be a time when she no longer had to think about how to react to all the situations. This would come about, here and in other teachers, over the accumulations of experience, which meant time and trial, where repeated trail was practice.

This belief was indicated above: each unique class has its own unique interactions that produce experience; the classroom was seen as a collection of nonrecurrent elements. Ella Finn declared in one of her descriptions that some things could not be learned. In the following description, she testified that there were some things she could not learn, things that also would not work for her or her students but that might work for another teacher. She had finished describing what the situation was like being in-between automaticity and high levels of CL, and then identified the "strategies" that she wanted to acquire

> I think strategies for creating a classroom with full student engagement, where I have no issues with students being not engaged. That would probably be my best—because I think that is the key to all of it. That's the key to my kids talking and being disrespectful, that's the key to, if they came into my classroom and they were like, "This is the coolest place to be. My mind is fully engaged. I can't think of anything else I'd rather do." If I can figure out the key to that, I think that would be—I mean, that's what I'm trying to

> work on. I feel like I don't know the answers to that, and I feel like I can't think of them on the fly. So I feel like— you know what I'm saying?

There was an interesting pivot in this account, when she described her learning as figuring out "the key to that," to her engagement "strategies," but then stopped herself to say, "I mean, that's what I'm trying to work on." Figuring out the key is trial, again, but also finding resources. She does not know the answers to engagement and cannot think of them on the fly, "in the moment." The researcher thought, at this point in the interview, of specific engagement techniques, redirection tactics, like the several levels of low profile interventions, or the kind of positive framing that narrates a story with a good ending that teachers can learn and apply with basic scripting exercises and drills; such expert, proven performances exist. But as Ella Finn continued, she clarified her beliefs about what could be learned and what could not be learned.

> And I have a certain—there are certain things that my—I don't know whether it's personality, or my person, or my mind could think of as go-tos and there are certain things that I would never think of, no matter how much training I had as go-tos. So, what might work for one person doesn't necessarily work for another person, I guess, is what I'm saying for those things that become a second language, as far as student engagement. So I need some practice at that, I need some more resources at that, and I need to be able to practice them. But I need to find the ones that are going to work for me and my kids.

There were two elements to her description. There were certain things she had, "personality, or my person, or my mind," and there were certain performances one "goes to," things to be learned. Some things could not be learned, integrated by her, she indicated, due to personality. She had been focusing her awareness on her own automaticity in the interviews, but believed some things could not be automated. She already had her own "go-tos," automatic practices that were immediate and available, but there were some things completely outside of her thinking, that she "would never think of, no matter how much training I had as go-tos." She apparently did not believe that training could automate most recurrent performances, that experts have identified refined techniques for most classroom situations, or that it is possible to train these "go-tos," but believed training could only go so far, due, again, to something internal about her: "What might work for one person doesn't necessarily work for another person in terms of "things that become a second language," her repeated expression and analogy for automated. But she also, in one sentence, indicated her need to practice engagement strategies, to be given resources ("certain things she would never think of, no matter how much training") for student engagement, and needed to be able to practice them. What does practice mean? Trial and error, the creative process within experience, would show if performances worked for her, and for her students, as she had already indicated in this interview:

> So for me, I think that seeing what happened in the complexity of the classroom (awareness) is the hard part, and deciphering how to fix that the next time around and remembering how to fix that is the cognitive piece to me. Because I can get into the same situation, and it's like I cannot pull—there's so much going on, I cannot pull that piece that I was going to remember to do out of my back pocket.

Experiences brought awareness, then deciphering and remembering brought the power to "pull" new performances out of the back pocket; but the process was formulation and creation and reliance on one's own awareness and deciphering skills to fix "that" for the next time the same situation arose. "There's so much going on" such pulling seemed impossible. What becomes of practice in terms of belief when it must be done in the classroom, in the complexity? The anecdote below brought together both Ella Finn's experience of drill, the practicing of a specific techniques, and also her belief surrounding immersion in an environment, the cumulative interactions of "practice" that produce "experience." It is a long anecdote, but it reflected powerful shifts in her awareness, from drill that automates (her experience in high school) to the reality of current classroom complexity, and indicated the stability of beliefs about experience, time, and trial. Notice, at the end, she suddenly inventoried the mass of information and the complexity which had forced her towards the belief in accumulations of experience as "practice."

> I think practice. I think, my theory and philosophy—and I'm going to come back to rivers —and learning to do any skill. And when I was in high school I didn't do high school—I did dance team, and at that time it wasn't high school athletics, it was dance team. But our coach was this drill sergeant. If the clock ticked and you were late, you were in big trouble. But what she always told us was, "You're going to have to practice that jump 1,000 times before your body remembers how to do that jump." So you have to practice that jump. So if you're taking a second language, if you're going to speak that, you have to practice that language. So I took Spanish in high school. Did I know how to speak Spanish? Well, I know the vocabulary and I know the words. But I can tell you when I traveled down in Mexico and Guatemala for three months after college, and when I entered Mexico I could barely speak Spanish. When I left Mexico I could speak Spanish. So I practiced it. Right? So I think that, as a teacher, it's the same thing. Okay, rafting. You're teaching people how to row a boat. The first day it's like, "I don't know how we're going to get them down this river. It's 5 days and we might die [laughter]." Right? So then, by late that day you're thinking, "Well, we might make it. We might make it." And then their body, their mind thinks about it overnight, and they come back

> the next day and it's like, "Wow. These are new people. I think we're going to do okay." So they start making this practice a second language. Right? They start assimilating it. And so I think for a teacher it's the same thing. But there's so many kids—there's 150 kids—so many subjects, so many different material[s]. There's the math modeling training. There's a co-teaching training. There's my mentor training. There's the form to fill out. There's all this other stuff. There's a switch in curriculum. There's planning with my team members. It's all awesome, but it's all just additional stuff that has to become assimilated into my person. So I think that's the piece. So practice. And seeing. Practice means that you get better at one piece, then you can see the other piece. And then you get better at that piece, and then you can see the other piece you're missing. So then, each time you practice, you get to add to your repertoire of proficiency.

Her last description of practice in this anecdote, progressive additions to the repertoire of proficiency, was different from the first description of her high school "drill sergeant." She gave the anecdote of her high school experience to describe "learning to do any skill." The drill sergeant demanded automaticity of practice; there was a clearly defined jump that had to be integrated into motor memory, practiced 1,000 times outside of and isolated from the final performance. But then Finn switched to immersion, to being in Mexico, being in the river, then being in the classroom. It is a turn to complexity, requiring practical contact within the complexity. She was familiar with the learnings from the river, the learnings of second language in Mexico. But when she got to the classroom, her mind immediately inventoried the complexity, the mass of information: "But there's so many [150] kids—" she switched suddenly, listing the subjects, materials, three different trainings, the forms, the stuff, the switches in curriculum, the different planning with team members, all of which was "additional" and had to be "assimilated into my person." These were unique and singular elements to learn and nonrecurrent elements of learning. But types of practice were equated, where "getting better" (not perfecting the jump), leads to awareness of the next piece. When one accumulates all the pieces through immersion, one becomes both aware and proficient.

Like Ella Finn, Ivan Jentz described his own learning as trying to get his arms around teaching and finding it slippery. As indicated already, teaching was a second career for him, and his first career was in a highly technical field. In this anecdote, he described "time," how learning to teach takes time, and he compared teaching with other jobs, and his description moved around beliefs about time and experience. He first describes a culture of learning where one is not expected to learn immediately, where one is given "a year" and not a week or month to learn.

> Jentz: Those kids are coming in still going to be who they are, and you're not going to lie awake at night and figure out how to—it takes time. And that's what I think is the most important. To try to get comfortable with that. . . . But it's totally different than being comfortable with something that you're really not going to change in the first week that you do anything, or the first month, or maybe the first 2 months. And that's frustrating if you think that you—or if you come from a place where not only should you do that, you have to do that or you're going to get fired. You have 30 days to get your arms around this job or you're going to go. Doesn't happen in teaching and thank God that the amount of support that I get from being like, "Hey, it's your first year." Not like it's your first week or your first day. They're like, "It's your first year." I don't know of very many other occupations where they go, "Take it easy on yourself man. This is your first year."

Learning to teach took time, the “most important” realization, and one must get comfortable with that. He contrasts this with other jobs; in teaching, coworkers offer support which consists of time allowances. Jentz was then asked for the reasons for this approach, and he described both a difficulty in learning to teach and also the need to be comfortable with not knowing what one was doing, functioning without having the skill or performance, for teaching was a matter of time, a matter of having “a year.”

Interviewer: Why do they do that?

Jentz: Because I think that the more you try to—the tighter you try to hold it, your arms around it, the slipperier it gets [laughter]. It’s crazy, right?

Interviewer: Yeah.

Jentz: And then the more frustrated you get. And so listen, I mean, embedded in that advice is, “Be careful or you’re going to not survive.” I mean maybe literally—

Interviewer: You’re going to give up or you’re going to stop.

Jentz: —but you’re going to burn, you’re going to—I don’t know. I’m not good enough. So and if you’re a certain person that isn’t comfortable in that, and you have to come to the conclusion, or you’ve come to the conclusion because you haven’t wrapped your arms around it in a month, that you’re not good enough, then that’s a whole another layer of frustration.

Interviewer: Have you thought that?

Jentz: No.

Interviewer: Okay.

Jentz: No, I haven’t because I’ve given myself a year. And it’s not like I go, “Whatever, I got a year.” I still go in ready but if—

Interviewer: But it's hard to get your arms around it.

Jentz: —it derails, or I have a bad day, or if I screw up, or if I look back and I go, "Yeah, I should've known better." It's good. That's a good day because now I have wisdom. If I don't spend time in a constructive fashion with a mistake or with something that I shouldn't have done or whatever, then I won't learn from it. And that's the patience that you need. And I started learning it in grad school. I didn't know what a rubric was. I didn't know what a reflection was.

The image of learning to be a teacher here was one of wrapping one's arms around the job, holding on to it, and teaching was too slippery to hold onto; if one was not comfortable with not having wrapped one's arms around it in a month, then "you're going to burn." The primary virtue was patience when time and experience, trail and error were the teachers and when they provided little. Such patience was something that began for Jentz in grad school, preparing to be a teacher, which is also a very different culture than what he expected.

Interviewer: It's a whole different world.

Jentz: And they talk about those things like it's a pen or a computer. The first reflection I wrote [laughter] it starts, "Yeah, I thought the professor was really nice and I really enjoyed my time in the class—" Thinking, well reflect on what do you think, right? Not what did you do good, or bad, or whatever. And I get this thing back saying, "Yeah, thanks for the compliments but you really didn't address what I—" and I'm like, "So that's what a reflection was." And then I realized at that point in time this—yeah, it'll all happen somehow or another. Whether it's delivering an assignment that you have no idea how you're going to do it. That you're going to have to do by the end of the term, the [redacted name] or whatever. You look at it the first day, you're like, "There is no way I'm going to do this. I don't know what they're talking about." And then you go through the process and you come out the other side. And you're like, "Okay, I'm okay with the notion that I have no idea what I'm doing, but if I stick to the program—"

Interviewer: You'll get it.

Jentz: "—I'll get it." You've got to believe in yourself enough even though you've nothing to hold on to.

The program wherein one did not know what one was doing, but merely was part of the process and must trust the process until coming out the other side was a provocative image. The last line, however, was notable regarding the purpose of belief. One must believe in oneself, although one had "nothing to hold on to." Throughout this anecdote, holding on, wrapping one's arms around something, were images of learning, images of knowledge; nothing to hold onto is teaching without being given learning. Jentz had discovered that teacher training, programmatic and in the classroom itself, gives one nothing to hold onto, that support in this profession meant being told "take it easy on yourself." Belief was what kept one going, even without learning being provided.

While novice teachers expressed their beliefs as if they were the natural order of teacher learning, the researcher considers "time and experience" and "the classroom as teacher" and "trial and error" as dispositions that should raise suspicion rather than give a novice hope. If one was in a profession that withheld real learning from or could not provide real learning to practitioners that profession might best be served by beliefs in trial and error, time and experience, and the environment itself being the primary teacher. Jentz was proposing the same belief that Amanda Betz did in the first anecdote of this section: one must persevere, that is, continue through difficulty. The awareness that was brought by cognitive load in the moment could well result in knowledge of what was missing from teacher performance, gaps in cognitive resources, but in the absence of real learning to fill the gaps, performances that were immediate and available in the moment, teacher beliefs seem to manage the gaps and contextualize these over time. These beliefs that were repeated among all teachers were navigational, and carried one through time, trial and error, till “experience” had been given. They were all related to “the not-yet,” what had yet to be learned and known by the teacher for them to access the accolade “experienced.”

Some elements of teacher learning design impacted and nurtured teacher beliefs, and these will be reviewed in the next chapter. Since beliefs are dispositions to action and behaviors that can be changed or overthrown with future knowledge and findings, it is important to give an indication of the limits of novice teacher beliefs, what these beliefs lacked in terms of experience and knowledge. Teachers were unfamiliar with the language of techniques and tactics, and struggled with a taxonomy for recurrent performances. They struggled to describe performances, to indicate goals and cognitive steps and triggers, and at times described performances for recurrent problems that simply did not work. Drill was something done with students. Drill was not part of novice teacher learning in any way, although some teachers would have liked to gain deeper automaticity by isolating skills and learning these outside of the classroom. When teachers claimed to rehearse “in their heads” complex performances, these were always nonrecurrent and related to daily lesson content (what changes every day). Teachers expressed that what they considered a priority to learn was different than their coaches’ or experienced teachers’ priorities. Programmatic learning was interesting, exciting, but not helpful for where they were. While teachers wanted to lower their mental effort, there was no sign that their expert mentors had this as a goal, or even that they were aware that novice learning needs were different from those of experts. No hierarchy of skills was indicated, an order of supportive skills to be learned first to clear mental space for other learnings, although teachers spoke of automating skills to do this. In none of the beliefs given above was there a learning path that specifically automated performances, making these immediate and available, but trial and error, time and experience and the classroom as teacher seemed to work against well-defined transfer of recurrent, proven techniques.

Structural synthesis. Immediate results of the novice teacher awareness of cognitive load included powerful shifts in perception of their learning as teachers. Automaticity was described as a goal and sign of expert teacher learning, described as performances that were immediate and available to the teacher within the simultaneity of classroom demands. While teachers highlighted different aspects of automaticity, its instant-ness, its effectiveness, the way such performances allowed for more space to do other things cognitively, the researcher summarized all of these as "real learning." Also, in terms of immediate results, teachers perceived, in moments of heightened CL, the two axes of defects in learning, (a) recognition of the lack of an immediate performance or cognitive resource (the "not-yet" discovered "in the moment") and (b) environmental distractions which prevent learning. Teachers also richly described the immediate results on their self-concept of higher levels of cognitive load. This section then turned to novice teacher beliefs about their own learning. Teachers believed in time and experience, that perseverance and continuing through difficulty characterized teacher learning, and that it could not be accomplished except over great amounts of time (years or "5 years"). Teachers believed in trial, that advice must be tried in class, and tested with particular students by teachers with particular styles and personalities, a process usually done alone. Teachers believed the classroom was the ideal place where experiences with students gave one "experience," where one must learn by doing, and several teachers indicated a creative process, one of formulation through interaction with students. How do the immediate consequences of cognitive load impact or interact with teacher beliefs about their own learning and learning design?

On one hand, teacher reconstructions of "the moment" describe mental effort intending a performance or skill to be immediate and available within classroom simultaneity; teachers who focused on this structure, the attachment of mental effort to specific objects within specific circumstances, realized new goals in learning and deficiencies in their learning. On another hand, teacher beliefs explained why this does not happen more quickly, why the mental effort of problem-solving and teaching performances remains; the classroom does not present an engineered form of teacher instruction, trial must be utilized, time is required. The emphasis on time and perseverance in teacher beliefs presents a different form of automaticity, a different engineering, than is found in CTA methods. CTA isolates skills to reduce distraction, and provides drills for higher levels of load and learning; teachers seemed to hold time as the method of automation instead, which makes sense. After five years of teaching, one would expect that teachers would not have to think about much of what they do in terms of problem-solving and recurrent performances. They would have automated a large set of responses, with or without formal methods to automate such cognitive processes. Veteran teachers might remain unaware of whole categories of techniques, of cognitive processes, but still may have automated their own responses to everyday challenges, might still "sacrifice kids to the gods of classroom management," or may have developed their own automated repertoire. This is real learning, but it also is not real learning.

It is real learning in the sense that the mental processes have been automated, and space has been mentally cleared for more nonrecurrent elements of learning, the daily content that is different every day and that veteran teachers spend their time focused on. There can be little doubt teachers were correct in their beliefs: trial and error, time and experience, and the classroom as teacher produce this automation after 5 years. Teachers believed it did. They were right. Five years translates into roughly 900 days and thousands of classes, and tens of thousands of cognitive challenges and performances. The experience that automates much of what they do, daily practical navigation of distracting classrooms, will produce this automaticity whether the results are desired or not, effective or not. Automation, not having to think about performances, would be a fact of the mind after a lengthy period of time and after many "tried" responses, and teachers after several or "five years" would have something immediate and available for most classroom challenges, but especially for recurrent challenges. They might become classroom mothers instead of teachers, or even bullies instead of instructors, but they would have responses automated. As teachers indicated, it takes years, as some said "5 years" of mental work and grasping and searching for what to do, to settle into the patterns and habits automation provides. The teacher would be acclimated, the environment would have become more comfortable.

This process of automation is also not real learning, in that it may take these years, and produce less effective practitioners. The absence of a more direct transfer of proven practices, a design which provides skills and increases their immediacy and availability, serves this belief in time and experience. Time and experience, trial and error, and the classroom as teacher equate to an automaticity that would not be engineered or created by design. "I want you to try this" from a veteran teacher is not engineering learning for automaticity. All teachers who described beliefs in the efficacy of time and experience, trial and error, and the classroom as a place of practical learning also indicated that they, by themselves, had to assimilate what they were given to “try,” to increase their own performance availability. The first year of teaching involved “everything” and the teacher was spread out by tasks and demands of learning and the learning was piecemeal or lacking in depth. They had to prioritize their learning. In this effort, they had few resources but the complex classroom itself, a distracting environment in which to memorize and naturalize cognitive steps. In some cases, they lacked techniques that constituted studied and proven responses, their practical learning “trials” were not isolated from the classroom, and they were offered no repetition of recurrent cognitive processes (engineered drills) to help them do this; also, and more importantly, they did not believe that teachers learned this way, that such was possible. They believed every classroom was unique and singular (that was, until actual automation presumably made them stop believing this). How did they assimilate the performances that served as trials? It was, for all, a discovery process, a kind of autopoiesis in an at times chaotic complexity. If they managed to remember to do what they had done the next time a similar situation arose, that marked the success of trial and error.

Although Amanda Betz had affirmed that she wanted to automate “everything,” she also believed that perseverance through time and experience would do it for her. Because the process of trial and error demands it, so much time, so much experience is needed. After “5 years” one would have automated enough things, cleared enough mental space, to have moved on to nonrecurrent and more complex elements of teachng. Simple endurance of complexity would bring experience about, or the repeated contact with challenges. Teachers could be “experienced” in the way that a stone in the river is smoothed, marked by the passage of time. But such experience does not necessarily mean real and deep possession of a body of learnings, of effective challenge-meeting techniques. Time wounds all heels, but it may not heal all wounds; time merely marks the teacher as “experienced” or not having to think much about the responses given but does not necessarily grant skills that resolve many classroom challenges in the most effective and productive manner. Veteran teachers are sometimes not good at what they do, are not experts.

Novice teachers accepted their complex environment with their resources in the form they were given, and were not aware of other options for learning. The bedrock belief: teachers learned from interacting with the classroom, from trial and error over time. Experience happened from trial, from error, and the trial and error times within class were “the teachers” of the teacher. The researcher noted that what was learned from experience (practical contact) and what results as experience (accumulations over time) are different meanings in all accounts. Advice that experienced teachers gave novices resulted in trial and error opportunities; over time, these resulted in experience. Whether Gina Hunt was describing going around and around and around for 5 years, or Kevin Long was throwing performances against the wall to see what stuck or Ivan Jentz was sacrificing to classroom management deities, trial of performances was not a formal process, and performances and skills were primarily information, until, after time, experience stuck.

There were conflicts between teacher beliefs and experiences of mental effort. Experiences of “the moment,” of simultaneity, automaticity and overload and higher levels of load revealed intentional objects and new goals for learning, but did not change beliefs, although some new awarenesses came about. For example, teachers maintained the belief that the classroom was their best teacher while descriptions of actual classroom complexity and how it impacted their real learning and problem-solving dramatically contradicted this belief. Teachers believed ongoing perseverance through time in class produced experience, that learning to be a teacher was a process of self-creation over time; however, they also demonstrated awareness of real learning, recurrent processing abilities, and went to "more experienced teachers" to outside experts, to be given these processes and performances. Teachers believed they had to try the advice of others in class, that trial in class proved the efficacy of a performance, whether it was right for the teacher and class; they also described efficiency in terms of automation, that recurrent, effective classroom performances became automated. Moreover, teachers described their own recurrent, automated responses to familiar challenges, how they acquired these through repetition, although they believed time gave something called experience.

While there were many consequences of CL, one consequence was absent. Awareness of CL did not produce new beliefs about learning design. Even Gina Hunt, who deliberately critiqued her learning design based on awareness of cognitive load levels, did not change her beliefs in time and experience as the great teachers. Awareness of different levels of mental effort and deficiencies in performances, mental resources or the environment did not make novice teachers wonder about teacher learning design. There was a gap exposed between reconstructions of mental effort and the beliefs about learning design held by novices; when presented with questions about the lived experience of learning in the classroom, teachers gave both reconstructions and beliefs. For example, while reconstructions of cognitive load indicated that teachers intended and desired specific and effective performances be immediately available in class, in the moment, and responded to the need for these by turning to experts for advice, teacher beliefs indicated effectiveness happened over time through classroom interactions, "trials" which could lead to error. Also, while teachers reconstructing their performances realized a need for focused isolation of skills as a desirable element of learning design, for an end to the chaotic distractions and mental strains of multiple classroom demands, teacher beliefs indicated the classroom as a positive source of learning. The emotional and physiological manifestations, the changes in performance occasioned by higher levels of CL and overload were passed over. Perhaps they were seen as signs of defects in learning, but fluctuations of levels of mental workload do not appear to formally impact how teachers saw their learning design. The main problem that the researcher saw was that novice teachers were not familiar with any learning design or belief system that was different or contrary to what they had experienced. Novices had never experienced expertise transfer learning designs for their recurrent practices; they only knew what they had known, and only learned how they had learned. The next chapter will look at the how teachers described their learning designs, and consider alternative methods based on novice teacher explorations of their cognitive load.

Chapter 5: Discussion and Conclusion

This phenomenological study brings together rich descriptions of teachers undergoing cognitive load in problem solving and learning so that their experiences and the meaning teachers may give these appropriate new depth and greater relevancy for teacher learning design. A turn from natural attitudes toward mental workload and theories of learning to wonder at what goes on in novice teacher cognitive processes produced a fuller exploration and elaboration of this lived experience. The lived experience of teachers integrating new, recurrent classroom techniques and solving problems within the complex life-world of the classroom and "in the moment" were the foundation of the phenomenon. Novice teachers reconstructed cognitive processes from real learning practice and the researcher discovered and generated composite structural and textural descriptions. This chapter (a) presents and evaluates the results of interviews, (b) interprets and provides personal insights regarding the experiences shared, and (c) connects these results to the community of practice involved in novice teacher learning design. The researcher apprises the literature of classroom teacher coaching and training, and offers additional confirmation to the learning designs of cognitive psychology and increases knowledge of how new teachers might be better trained for classroom teaching.

Summary of the Results

While CL has most often been studied in controlled learning experiments that monitor the results of learning designs and attempt to measure CL through various methods, this study's purpose was to explore CL through the lived experiences of novice teachers engaged in learning within complex classroom environments. The intention and objective of the research was listening to novice teachers. The purpose of this study was met by answering the following questions:

1. What is the experience that novice teachers have of different types and levels of mental effort in complex classroom environments?
2. How do novice teachers become aware of their own CL (i.e., emotions, student responses, confusion, frustration, self-concept, automaticity, and efficiency)?
3. What do novice teachers experience as the consequences of different types of CL on their development of expertise?
4. How do novice teacher perceptions of CL provide insight, if any, about the relevance of specific learning designs for teacher expertise transfer?

The goal of this study was not to prove a hypothesis or to test CLT, but to enrich understanding of the phenomenon CL. Phenomenology was the most appropriate beginning for the study of CL as its methods offered tools for exploring the essence of the experience.

Phenomenological Dialogue

In the literature review, the researcher performed a first phenomenological epoché, a turn from the natural attitude toward mental workload in teacher learning and problem solving and a turn toward concepts and practices of CLT and CTA. Every person, expert or novice teacher, teacher-coach, student, administrator or parent, has a natural attitude to the art of teaching, a set of explanations and beliefs regarding teacher behaviors. Educators have ways of considering and explaining teacher overload, frustration, or inability to handle extreme complexity: for example, difficult students, low pay, poor self-management skills, the result of lack of charisma or natural-born teacher ability. Instead of considering CL as a meaningless chaos, this first turn considered the experience as a meaningful phenomenon, that the life-world of everyday novice teacher experience—the world belonging to psychological subjectivity—could be considered instead through the lens of cognitive load theory. The literature review both surveyed and summarized

CLT, the techniques of CTA and the particular practical applications of Doug Lemov in order to both bracket these and to develop the analytical tools for coding, theme-building, imaginative variation, and phenomenological reduction; however, this epoché did not represent a complete bracketing. The method of phenomenological interviewing and interpretation represented a second phenomenological turn that subsequently bracketed the presuppositions of CLT and CTA in order to allow the foundational phenomenon to be perceived naively and with fresh eyes, a bracketing of the theoretical framework. Theoretical frameworks and categories of teaching were put aside, as much as possible, in the process of listening to teachers, and asking, simply, "what was that like?"

While the conversations and anecdotes were very different than any the researcher had experienced in his career in education and teacher support, the difference was not due to an imposition of theory or categories. The difference was a change in focus, an attentiveness to cognitive processes as lived experiences. While this focus on mental process is shared by CL theorists and CTA, by using open questions the researcher was able not to impose theory upon the life world of the teachers and arrive at real experiences. Questions were framed to arrive at real experiences of cognitive processes during learning and problem-solving, and the researcher worked to minimize theory. Teachers described particular lived experiences undergone in the moment of accessing mental resources, of mental effort, and each was evoked in what the researcher would describe as an anecdotal singularity, a unique event for each teacher, a moment of searching and straining for a response to students or of immediate response to the life-world of the complex classroom. Novice teachers drew on their learning in these singular moments, and discovered their learning. Their mental processes were uniquely theirs. Teacher awareness and focus were shaped by the exploration of mental effort as well as descriptions of interior cognitive happenings in problem-solving and the introduction of recurrent practices. Novice teachers described their practice almost entirely in terms of singular and unique cognitive processes instead of external events, and when describing environmental complexity or happenings it was almost always in reference to mental processes. The focus was on where learning happens, in the memory, and how learning and problem solving are undergone in practice, the limitations and capacities experienced. Novice teacher mental effort took on new shapes and dimensions as teachers described mental performances within the simultaneous (real-world) demands of the classroom, the amount of information they were interpreting during performances, and what occurred, mentally, "in the moment." The moment was always coming and going and placing demands, and teachers were aware of how their levels of memory, their levels of cognitive load impacted mental performances. They described tactics and pivots within multiple challenges, and solutions and frustrations: performance immediacy and accessibility within the mind emerged in their own words. The researcher presented experiences of novice teachers, not taking these for granted or considering these as they seemed, but allowing these experiences to be as they were.

The researcher exposed two CLs, one in scientific research literature (the literature review), and the teacher's mental limit as really undergone by teachers in the classroom, "in the moment" as teachers intentionally integrated new learnings and problem-solving skills into their practice. In data analysis, the researcher's phenomenological naiveté and wonder did not involve elimination of the theoretical or categorical CL, but brought the bracketed CL into dialogue with real experience of mental effort in learning and problem-solving. For heuristic purposes, categorical CL and real CL represented the two different polarities within this phenomenology, the categorical and hermeneutic (Pollio, et al., 1997), and formed a hermeneutic circle. Both poles, the ideal-theoretical and the real-lived experience were necessary. A dialogue of both CLs occurred in the intentional experience of the researcher, the real CL of the text and the ideal pre-understanding of the researcher, and led to meaningful themes and fuller description. Because the researcher bracketed the understood and exposed CLT, the prereflective descriptions of teachers could be explored to develop a fuller essence of the phenomenon, an exposition of awareness of CL and the categorization of results of real CL as experienced by novice teachers. The findings are summarized as follows.

The Research Questions

What is the experience that novice teachers have of different types and levels of mental effort in complex classroom environments? The essence of mental effort for teachers was, specifically, the struggle or ease of grasping, in the moment, for immediate and available cognitive resources and performance steps from memory within the complexity (simultaneity) of classroom environments and concurrent mental performances. Singular and unique descriptions of the environment and of mental processes demanded and enacted within the classroom condensed into this essence for novice teaching. Novice teachers described the simultaneity of performances demanded of them, the multiplicity of responses that occurred "in the moment," and the struggle or the ease encountered as they searched for their next actions or words. It is a powerful finding, not to be discounted, that every event of mental effort as described by teachers was intentionally bound and indivisible from a mental resource, a performance, or, in cases of frustration, to the awareness of the lack of a performance. Singular and unique anecdotes throughout the data analysis exposed how teachers not only measured their effort, but took its direct measure from a performance's immediacy and availability in itself as experienced in the classroom and among concurrent mental demands. CL was always discussed in the context of learning and of acquiring problem-solving skills, as a learning phenomenon, and teachers themselves bound both together in description and explanation.

Complex simultaneity. When teachers described their very diverse and unique moments of simultaneity, it was always in reference to *this* performance or *this* resource being immediate in *this* complex and challenging moment, and it was a measure of learning. In describing simultaneity, Amanda Betz asserted she did not ever "want just one thing" but was seeking a "multi-tasking" in which she felt "comfortable and competent" and she had asserted, moments before this,

> I think as time goes on, I'll get better at knowing what to do and quickly and efficiently doing it. And so, yes, it's technically complex, but if you kind of break it down in[to] all these simple little things, it won't be as bad.

This was description of a learning spectrum that was changing, through learning, within classroom simultaneity challenges. Awareness of cognitive load made her aware of this spectrum. Ella Finn also hoped, through her learning, to be that person who eventually "juggles 50 things at once and you can tell I'm juggling" even though her automaticity would make this "feel like second nature." Ivan Jentz knew his struggle with simultaneity was a part of novice teaching. Gina Hunt experienced her simultaneity of challenges as a spreading out of her learning, a making of "mastery," a "covering of ground" and "deepening" complicated by "too many things." Hunt was trying "to be able to reach and use a tool that you're trying to use" and perceiving this, in her own words, through reconstruction of a "level of consciousness" and "clarity," the moment of cognitive load. Whether Ella Finn was assessing her prediction skills in the midst of challenging cognitive processing or Gina Hunt her ability based on behavior distractions, or with multiple other teacher descriptions, reconstruction of cognitive processes in simultaneous challenges and the effort of grasping resources led teachers to real measures of their own learning.

Noticing skills. Levels of effort and active awareness of the classroom challenges were both bound to teacher self-measures of their learning, their "noticing skills," and without encouragement from the researcher. The fluctuating environmental demands for growing and active awareness and mental shifts in levels of effort pervaded teacher experiences. Noticing skills were the intentional focus of most anecdotal accounts of load. Teachers faced the challenge of communicating experiences in their environment by creating analogies and by layering descriptions. Ella Finn, ever on "the river," lived in an expanding and contracting "circle of vision" but was ever coming to see the "deer on the shore" more often and more clearly through her learning process; her noticing and awareness and all other aspects of her learning were a constantly shifting spectrum of learning levels perceived by her through the lens of the cognitive load she was reconstructing. Gina Hunt's map of fires represented the challenge of learning to notice; from "month one" and "down the road to today" she had a learned awareness of "which ones are going to be most active" along a spectrum of learning revealed in reconstruction of her CL. When Amanda Betz described her own noticing, she was describing a skill "which hopefully will become just automatic and I'll know it instantly" like the expert teachers she experienced; she was "not there yet" but, more importantly, was describing a measure of her noticing skills according to unique and singular CL reconstructions. Betz described her noticing, comedically, as being taken apart physically, her left eye and right eye operating in different directions, but only because one performance had become "automatic" and she could "always" scan the room, but this was the goal of her learning, her "getting better." These are examples of the how mental effort and learned performances are bound together in actual experience. Mental effort always was associated with a learned object or resource, and mental effort revealed unique elements of that skill as it operated in its environment. It is what the researcher would call a "bound essence" in that *this* cognitive load was always experienced with *this* resource at *this* level of development in the novice's learning. What was most powerful in the separate anecdotes was that although each was different and represented a different teacher in multiple different classroom situations, descriptions of different levels of cognitive load brought unique descriptions of a performance or mental resource associated with it. No awareness of mental effort as described in classroom practice could be separated from the singular and unique level of learning of a performance in teacher description. This is a powerful finding in that it represents a new way to explore and evaluate teacher practice. To compare this to what usually happens in teacher discourse about practice is necessary. In the researcher's experience, when teachers are asked to evaluate their specific skills, they often stand back from events and offer abstract reflections from the outside, as in "my circulating technique is getting better"; one may compare this to descriptions of teachers communicating their levels of load in circulating, for example, offering without prompting descriptions of the simultaneity demanded in that moment, analyzing the events of the classroom that impacted their internal mental process while moving or deciding to move, and describing the grasp they had on this practice and others as they were concurrently delivering a lesson and redirecting students and noticing who needed their greater proximity. Amanda Betz offered just such a description in this section of Chapter 4. Cognitive load connected performance level with environmental conditions where these really occur, in the mental process, and added gravity to the moments of teaching, the real enactments of performances, and granular assessments of mental capability.

Automaticity. Teachers could immediately and casually describe the moments in classroom practice when skills and performances were automatic. Automaticity (e.g., not having to think about performances, doing them "naturally," possibly without much awareness, and having the performances be efficient with students) was recognized as arrival at expertise for Kevin Long and others. Learning new skills over time meant Amanda Betz would "feel more comfortable and confident quickly and efficiently addressing" noticed issues, and "knowing what to do and quickly and efficiently doing it." Kevin Long described automaticity in his initial steps of a performance by contrasting it with an abrupt moment when he was "having to think on my feet" for a third or fourth step when his responses were unclear. For Amanda Betz, having gotten better at very recurrent performances, having learned them, meant not thinking about them, not recalling specifics, and Catherine Doe's growth, her getting better at transitions, came with learning transitions over a year until she found them effortless, done without thought, recognizing them as not even important or not a thing to work on or focus on. She said she decided to do what had become automatic, and it "just kind of happens," and that with greater automation, learning what to do, she would be more efficient and need to think less, "just handle" things like more experienced teachers have learned to do. Amanda Betz consistently spoke of automaticity in the now and the not yet, as something hoped for, that would eventually come so she would "just do" performances on cruise control, without touching the (car's) pedal, a "getting better" where performances "could become more automatic and flowy." Betz was aware of differences from the beginning of her novice year, which led to an increase of mental space, of increased capacity for other performances and thoughts due to learning, that due to her practice she had come to do "more" because of knowledge gained. Ella Finn spoke of this increased capacity as well, that becoming like an expert teacher would help her manage her mind to think through challenges "in nanoseconds." Again, these were measures along a spectrum of learning, the result of awareness of CL's diminishment through learning that arose during reconstructions of the objects of effort, performances both immediate and effective due to learning over time. Again, evaluation of performances was bound to a level of load, and the performances described were very specifically associated with the levels; teachers reached for examples when describing the automatic, and associated expertise with a type of performance.

Overload. When teachers experienced higher levels of load or overload, they identified it along with a performance that could not be grasped completely, and associated its lack of immediacy to inadequate learning or to environmental and separate mental demands distracting from or preventing performances. These were the two axes of explanation bound to descriptions of overload, as when Amanda Betz associated her mental overload in moments with a specific challenging student with not knowing what to do, with reaching out to other teachers and counselors for answers and finding none, with not being able to learn the solution. She could no longer cram any more information or cognitively process more in the small space she reconstructed, a space she could not fit her simultaneous performances within. Her exhaustion of all her resources, a feeling of being "overwhelmed" led her to recognize a need to confer with others, to "get some tools, try them out tomorrow." It was a measure of specific learning, (e.g., a change from the beginning of the year when she was overwhelmed very often, often "thinking on my feet," to "getting better at that"), or the sign something needed to be fixed or a need to grow in the coming year or years, (e.g., that something was "not as good as it will be"). Catherine Doe judged from her moments of higher load that she might "need to be changing something to lower it . . . sometimes I don't know what." And Ella Finn was not "assimilating information" in those moments, spinning in an eddy on the river of her learning. The strength of a cognitive process was measured in the moment when such processes were most needed, a moment of standing back reflectively, of learning about their real learning. The environment could make performances at such moments impossible, put a novice teacher "underwater," as Gina Hunt indicated or Ivan Jentz's swimming against the current attempting to formulate a plan which had not been given. While teacher beliefs consistently maintained the classroom as an optimal place of learning, at times the actual moments described by teachers of attempting to access skills contradicted this; the classroom's challenges, the simultaneous demands and concurrent mental processes required, frustrated novice practice and skill acquisition.

High cognitive load. Explorations of higher cognitive load made teachers aware of powerful fluctuations in learning process. While the study design, rooted in complex classroom experiences, made it difficult to find that ideal level of load for learning, the load most often studied in controlled conditions, teachers indicated a desire and awareness of the kind of focus and intentionality necessary for learning. Catherine Doe reconstructed the introduction of one of her techniques, moving between awareness of "I don't do it automatically" and the moments of having to "think" what she was doing, an in-between space of changing capacity, and the change in level that has occurred over a year with greater learning. Ella Finn very directly described learning levels and levels of load, comparing her own learning to teach to her learning to type or gaining ground in a second language; she was aware of a movement from cognitive effort in singular steps to being able to process information with ease and flow. Gina Hunt reconstructed her shifting "energy" and "level of consciousness," her "level of clarity," and described a felt need for these "in the moment" of classroom management. She had the recipe book of performance steps, wanted these in front of her, but her goal was to set it aside and perform automatically. In spite of the "learning" given to her by her mentor, several explanations of reading groups, she described a frustration with not having skills and mental resources automated, that the procedures did not "click," and the frustration that she should work by herself to build the "bag of resources." She asserted that focused practice, outside of classroom complexity, would transform what was merely information to real learning and automation.

How do novice teachers become aware of their own CL (i.e., emotions, student responses, confusion, frustration, self-concept, automaticity, and efficiency)? Multiple directions of teacher awareness accompanied descriptions of CL. Cognitive load has been described as a theoretical "lens" by researchers who study teaching (Moose & Pitton, 2014). Based on awareness of mental effort in accessing mental resources, novice teachers reconstructed types and levels of CL, demonstrated new awareness of the performances associated with these, and described awareness of how changes in environment and specific challenges "in the moment" impacted cognitive processes. They were not interpreting experience through a theoretical lens, but instead were describing a lived-through awareness that gave shape and weight to specific acts of teaching as measured by their own mental capacity. Awareness of load did not happen separately from performance and mental resource immediacy. Reconstructions of grasping for performances "in the moment" made teachers aware of the specific challenges simultaneously presenting in the classroom, and of the pervasive effort of noticing, of split attention, emotions, time sense, and physiological changes. Teachers described their learning at a new depth.

"The moment" was an invariant constituent for reconstructions, the fleeting singular tests of memory that passed so quickly they were hard to put into words. It was a moment of decision on which the cognitive process hangs, when mental performance either succeeded or failed but was known and measured. The moment was a relentless obstacle to skills happening or one would know the skill in the moment and pull it out of one's pocket. It was in this moment that awareness of real learning happened, where the performance or resource was known along a spectrum of availability and complexity, whether decisions could be immediate for the moment and in the moment. The moment came and went as complex interactions were demanded and challenges were met or passed over, and teachers described the moment as one with weight. The moment was perceived through the focus on cognitive processes constantly grasping for resources. This section also presented exemplary lists of the multiple directions of awareness teachers had of multiple elements of phenomena associated with cognitive load and practice; again, these were not the result of analysis, but were direct awareness of new levels of classroom complexity through the mnemonic strength of their own skills. This awareness came about through reconstructions of "the moment" of cognitive load, and demonstrated that awareness of mental effort was also awareness of elements of learned skills and their steps in their real environment and in the mind. The structural analysis also demonstrated, in one profound example from Amanda Betz, the specificity and singularity of different directions of awareness attached to performances due to descriptions of fluctuating load in the shifting challenges of the classroom. The interview was the tool that made such awareness possible.

What do novice teachers experience as the consequences of different types of CL on their development of expertise? Teachers reflecting on the meaning of their experience described the results of the types of CL on their development as teachers. Because CL is a learning construct, conversations about learning and problem-solving in the complex classroom focused where learning really takes place, in the mind, in the mental processes. Teachers were aware of these processes when they stood back and reflected on them and made judgements about their skill levels and performance knowledge. Descriptions of automaticity exposed this as a major goal in teacher classroom learning; automaticity made everything easier for teachers and opened up mental space for other performances. Teachers expressed the desire, in reconstructing the moment of grasping for performances and directing awareness to their real skills, that mental resources for recurrent practices be immediate and available. Descriptions of higher cognitive load focused on what was lacking in performances and mental resources or on an environment that was distracting. This resulting two axes of learning deficiency reiterated those descriptions of overload from the first research question that also exposed the two axes of learning deficiency. Teachers also described the "everything" that needed to be learned in the first year of novice teaching, where overwhelming complexity of needs and their limited memory and skill capacity met and had to be managed.

Teacher learning and effectiveness was impacted by their environment, the demands of which were urgent. Kevin Long described how the complex environment decreased his focus, diminished his attention and full energy in performance, and lowered his effectiveness, as well as "learning quality." Amanda Betz described how "flow" was thrown off by "mass volume of so many people in here" and also her effectiveness. Multiple anecdotes from other sections also described environmental conditions that decreased focus and kept teachers from performances and resources. Teachers also described lower self-esteem as a result of limited capacity and skill level meeting the challenging demands of the complex classroom, even leading them to question if they should be teachers.

While teachers were able to reconstruct the moments of being frustrated in learning and problem-solving by the levels of classroom challenges, they also maintained several beliefs regarding learning design throughout the interviews, dispositions that conflicted with their own descriptions of lived experience. Emergent themes revolved around the navigation of complexity of classroom interactions, wherein "time and experience" with "trial and error" helped one move through classrooms in which creative interactions were the best teacher. These beliefs served as a road map to becoming "experienced" teachers. While Kevin Long described an experience of the trial of a new skill in his demanding classroom and the load it brought, and declared it as not helpful to learning, he immediately asserted his belief that trial and error did in fact help his learning; for him, the real experience of a trial and his belief about trial were evaluated both negatively and positively, although the same process was being described. He received expert advice, and threw it at the wall to see what stuck. Experience was the result of perseverance through time in the classroom for many teachers.. Five years of being spread over many types of learning seemed to meet the goal of having "a little bit of information about many things." Teachers not only associated learning new skills with "trying" or "trial" in almost all instances, they at times saw teaching as trial and experience without finished results, or even held there were no experts, only teachers increasing experience. There was a gap exposed between reconstructions of mental effort and the beliefs about learning design held by novices; this was not imposed by the researcher's own theories of design, but was expressed by the teachers themselves. For example, while reconstructions of cognitive load indicated that teachers intended and desired specific and effective performances be immediately available in class—in the moment—and responded to the need for these by turning to experts for advice, teacher beliefs indicated effectiveness happened over time through classroom interactions and experiences. Also, while teachers reconstructing their performances realized a need for focused isolation of skills as a desirable element of learning design—for an end to the often chaotic distractions and mental strains of multiple classroom demands—teacher beliefs indicated the classroom as a positive source of learning. It seemed to the researcher that teachers had been indoctrinated into the belief that immersive experiences of an environment and constant interactions generated meaning through reflection, and that this was learning. Teachers maintained beliefs that increased their tolerance of cognitive load in spite of the expressed desire to reduce cognitive load given in reconstructions.

Discussion of the Results

The researcher believes that novice teachers have something powerful to tell their educators and trainers, a message that has remained unexpressed. The message is simple. They are grasping for effective performances moment-to-moment of every day. They need mental resources for performances for recurrent practices and a type of learning that will make these immediate and available to them. Their most constant experience is of *the constant effort* to perform as good teachers, as well as the earnest desire to develop immediately accessible skills and performances that will make the most difference to students in the classroom. This effort, which pervades each moment, occurs in their minds as CL in problem-solving and learning, a mental phenomenon of teacher learning, and their level of effort there is often not expressed; the reasons it has been kept secret are difficult to grasp. Novice teachers may not want anyone, students or trainers, to see them sweat, as Gina Hunt indicated. Since their efforts were focused mostly on recurrent tasks that, as Amanda Betz considered, were “not super-important” their struggles may be kept secret. Or this effort may be dismissed because it is something novices alone work to overcome, something they try to, and eventually do make disappear through practice, a rite of initiation. For this phenomenological research, six novice teachers let their mental effort out of the box and unpacked it.

Phenomenology has many different varieties in scientific research and in education. In its most basic iteration, it may be called the study of structures of consciousness as these are experienced from a first-person point of view. The central structure of a lived experience is its intentionality, how a person's mind or awareness or perception is directed toward something. Experience is always an experience of or about an object. Further, experiences are focused toward objects by virtue of their content, or the meaning that represents the object (Smith, 2018). This study was very much along the lines of this most basic description. The study posited that an experience was in fact a relevant and meaningful experience: when one is learning and practicing in the classroom to be a teacher, one's memory capacity and mental effort is important to learning and learning design. Mental effort as described by those living through this experience revealed a structure and intentionality unique to teacher learning and learning design, and the unique and singular shapes of novice teacher experience in the life-world of the complex classroom.

This study deepened understanding of this structure of experience and its intentionality in classroom teaching. The researcher did not attempt to confirm theories of CLT or the designs of CTA; these learning designs already have been proven and embraced by other fields of complex learning even though they are ignored in most quarters of teacher education. While the researcher hopes that rejection of CL as relevant may be considered problematic someday for teacher educators, this research only asked the open question, "What is it like . . . ?" and explored the diverse and shifting directions teachers revealed in their accounts of cognitive processing effort. The conscious experience of novice teachers *as experienced*, how their introduction of new skills and problem-solving impacted mental effort, and how such mental effort impacted their learning and problem-solving produced powerful directions of intention and awareness in rich anecdotes. Teachers "in the moment" grasped for performances and steps of skills from their mental resources, even as these resources were sought during concurrent mental processes and demands, even as complex simultaneous demands asserted themselves in the life-world, and rich descriptions occurred that were, in the researcher's experience, unique to the world of teacher learning design. These singular and unique experiences could be contracted into descriptions of conscious structure and intentionality and were meaningful to these novices endeavoring to learn. Although CL, a theoretical construct of cognitive psychology, describes types of load along with levels in the endeavor to design learning and predict outcomes, novice teacher descriptions of lived experience produced anecdotes of meaningful analogies and layered directions of intentionality and awareness of unrepeatable moments. The ever-fluctuating classroom demands were explored within the shifting and changing mental demands that occurred. From the place where real learning happens, within the psychologically subjective events of teacher minds, teachers described real skills built upon learning, or struggles resulting from deficiency of learning or deficiencies of the environment.

The grasping for resources or performances within memory was always occurring for teachers, and was always inextricably bound to its intention: complex skills and resources for the classroom. Even when this conscious intention was most frustrated, teachers asserted that something must be there, a performance yet to be learned or developed. Teachers not only expressed the intention of their mental effort, a performance or mental resource, but also that it should become over time in the classroom an immediate and available resource that met the demands of the complex classroom. This becoming immediate, becoming available is learning, although it was often unclear what type of learning or how learning would accomplish the goal. In cases of overload or higher cognitive load the response had simply not been learned; teachers at this moment of recognition always described reaching out to other teachers or reviewing a known skill that could not be accessed in the moment. CL was never mere stress-reaction to a class, a mental state disconnected from environment or objects of memory. It was the cognitive process of grasping toward learned performances, or for resources that had not been fully learned, initiated by specific classroom goals and demands. Novices had known teachers who seemed to have all the solutions, and perhaps this structure of intentionality resulted from this experience: there must be something that meets this classroom demand. Moreover, some teachers more than others revealed a powerful awareness of their skill levels based on the immediate experience of grasping for these skills, and were able to describe their level of learning from these singular experiences.

CL is not merely a theoretical construct, but is first and primarily a real and pervasive phenomenon; it is given an ideal and practical form through the construct, but is known in singular and unique moments. CL as a phenomenon has been explored in order for depthful understanding to be achieved, but also in order to open new pathways to future teacher support. The interviews and their resulting themes demonstrate how deeply teachers themselves may analyze and describe their own learning if given the correct lens, one that is also most relevant to their daily experience and available for scrutiny and description. Learning happens in the mind, is often a result of its effortful actions, and reconstruction of mental events within classroom challenges have great power to inform teaching practice. The anecdotes from diverse teachers demonstrate that their attention to and awareness of cognitive load in classroom situations forms a key to identifying the real strength of discrete techniques within the classroom. Teachers fluidly moved from the experience to new valuations of performances in the moment, and their own need for greater resources, and also identified what had been automated and was most efficient in their practice; this was due to the intentionality intrinsic to the structure of this experience, the bound nature of mental effort and its particular objects in their environment. The interview was not only a rich source of information, but also had the potential to be, itself, an instrument of learning. When people share their stories, they come to new levels of awareness and come to teach themselves about themselves. Helping participants to discover the limitations within their memory through stories of real learning experiences gave them powerful self-knowledge from the best source of that knowledge, the individual learner himself or herself. The cognitive load interview took the most difficult experiences of teaching and converted them into useful and meaningful information, stories of limits and liberty in the moments of classroom teaching. This study was an example of the kinds of conversation that bring self-revelation for the purpose of understanding how learning works. The novice teachers in these interviews did not have CLT explained to them, their own accounts grounded the theory through the demands of learning that teachers reconstructed themselves. Rich descriptions of how novices negotiated classroom complexity, learned new techniques, and solved problems were a source of wonder for both participants in such conversations, and all great learning begins with wonder.

Trainers would do well to consider the above affirmation of the novice teacher-learner as self-teacher. The anecdotes of this researcher reveal powerful awarenesses. If trainers ignore the experience of cognitive load, so pervasive and informative regarding real teacher performances, they risk the danger of becoming irrelevant, of presenting programmatic learning that will take a lower priority, as Ella Finn described. All novice teachers indicated the urgency of habituating and automating recurrent skills to meet endemic classroom demands, and how other more complex elements of teaching were eclipsed by these. Trainers need to focus with novices on where the load is overwhelming, what automaticity means, how to optimize load in order to develop long-term memory schemas, and utilize methods of instruction to make novice teachers more aware of their cognitive load for discussion.

The study revealed flaws in the interview question design, but these were overcome by the relevancy of the subject to novices and the depth of their experiences. But flaws could be perceived by the researcher after the phenomenon was explored by teachers, and the basic structure and intentionality of their CL was revealed. First, novice levels of awareness might have been more deeply explored if novice teachers had more experience with the language of complex learning. While Lemov (2016) may distinguish techniques from strategies, the distinction was foreign to novice teachers; teachers also struggled with taxonomies to describe their skills; while teachers were able to reconstruct the cognitive steps of particular performances, this was a new experience for them. Complex learning designers identify very specific steps of performances, identify triggers ("if—" and "then—") and specify goals to notice in communicating skills, and trainers isolate learners from distracting environments so they might focus on each intrinsic element for practice. Knowledge of intrinsic elements of their own performances was missing and seemed foreign to novice teachers, although, when asked directly for steps of performances, they were able to describe steps in their mental process and fluctuations in load during their processing of identified steps. The intrinsic complexities of steps in a performance eluded some of the participants.

Second, the researcher began the second interview with a review of the observed class. After completely reviewing details of the entire lesson, he invited novices to reconstruct certain points of their lived-through experiences. Novices also identified instances of higher load and greater automaticity, and explored the skills they had chosen to introduce and practice. However, aside from several instances explored in chapter four, most descriptions were of specific circumscribed events and performances. In retrospect, the researcher wishes that this review had been more broken-up, and that the format had more deliberately allowed comment on each element of the lesson as these transitioned to other elements. The researcher wishes this due to several very granular descriptions of awareness of fluctuations or shifts in cognitive load, which he had not expected. When teachers described changes in cognitive load related to classroom happenings and availability of mental resources, the awareness of the shifts brought rich descriptions and powerful awareness. Amanda Betz was able to describe these changes in great detail, as though she was on a rising and falling roller coaster. Moving teachers from one performance to the next as other performances were demanded might have drawn on deeper levels of awareness in other novice teachers.

Last, while the most intense part of the experience of learning was made central and relevant, the conversation did not include discussion of how to best diminish it. While teachers shared facts and opinions regarding their current learning design, these remained disconnected from the phenomenon described. Whether teachers were describing the automated elements of practice or performances that were deficient due to a greater awareness of cognitive load, learning designs that would bring about a change in levels of load, increase germane load and impact long-term memory transfer were left out of the conversation. When teachers were asked about drill, this was foreign to them, and they could not reconstruct working with the intrinsic performance of skills in isolation. While the cognitive load interview revealed many aspects of teacher learning, it did not actually reach for a fulfilling conclusion, the identification and exploration with teachers of possible new methods for overcoming high or overwhelming levels of load. This could have advanced the study, but was beyond the scope of research questions.

Discussion of the Results in Relation to the Literature

This section discusses the connections and relation of results to the literature and academic and education community. It also explores some answers to the second research question, which was, How do novice teacher perceptions of CL provide insight, if any, about the relevance of specific learning designs for teacher expertise transfer? The literature review explored expertise transfer designs as these relate to cognitive load. The implications of the connections and relationships will be expanded in the practical section below. The literature review broadly exposed CLT as a psychological construct and its applications in complex learning, considered how expertise transfer designs compare to constructivist learning designs, and how experts who may wish to pass on their experience may be blinded by their own expertise as teachers. The research connects to the literature in three ways. First, the cognitive load interview, as an instance of phenomenological listening, changes and contributes to the study and practice of CLT learning design. Second, the research reaffirmed essential elements of the conflict between expertise transfer and constructivism. Third, the experience and awareness of novices indicate a gap between the way novice teachers perceive learning and the way experts consider it in ways predicted by the research.

The Cognitive Load Interview as a Tool for Research and for Teacher Learning

While the researcher is familiar with the literature of CLT and CTA, he has never encountered anecdotal descriptions of learners or a phenomenological interview structure in this research. CL theorists apparently have not availed themselves of experiences that are so singular and unique, or an interview that focused the complex learner inward in the way done in this research. CLT largely has chosen quanititative studies and measures of cognitive load, and avoided qualitative explorations. However, many CL theorists have expressed dissatisfaction for current measures of dynamic levels and types of cognitive load, and recommended further research into teacher cognitive load (Feldon, 2007a). Subjective reporting of CL consists largely of Likert-type scales, and CL types and levels have largely been utilized to test learning designs in the hands of expert psychologists. Ella Finn described her own programmatic learning in terms of the theoretical and practical in a way that connects to this theme:

> Well, I'm learning by doing, which is what I'm interested in, anyway. And we did a lot of—I mean, you can read theories all day long but it doesn't necessarily mean that's how it works. And it doesn't necessarily mean there aren't multiple things going on rather than just the one application to the theory. And it's hard to create a scenario that's representative of what's really going to transpire in a classroom.

She was describing a complexity that was both of the mind and of the life-world, one which could not be reduced to types and theoretical constructs. To explore CL from the voices of learners immersed in the experience who are constantly encountering its fluctuations as multiple performances are demanded could produce new descriptions and understandings, and contribute to the literature of CL measurement and design-frameworks. The cognitive load interview could be refined as an instrument to promote real complex learning in learners by facilitating transformative conversations, descriptions that create new awareness. What is lacking, in the researcher's opinion, is a powerful sense of wonder at the phenomenon and at the unique and singular ways that complex learners navigate through it. Learning and, hence, teaching demand such wonder.

Although the researcher studied novice teacher learning and learning design through the lens of mental workload, this research is not formally a psychological study. However, the research has the potential to expand the study of CLT and CTA in two ways. First, it is a *qualitative* study of the lived experience of CL and not a *quantitative* experiment on the effectiveness of learning design. Intrinsic load as a combination of task complexity and learner characteristics and extraneous load as a result of inefficient learning design are types of mental effort; this study expanded this typology, increasing understanding of the elements of these loads specific to teaching skills, qualities of learners, and of learning designs that demonstrate different levels of efficiency. Qualitatively, the researcher listened to real experiences in order to take the "types" within quantitative CL studies and reconsider the people and skills and designs these cannot fully represent. The phenomenological interview is a step toward a more formal, better developed, CL interview process.

Second, while CTA learning designers usually elicit knowledge from experts in particular skill sets and develop learning designs from expert testimony and from their own expertise, this study examined—albeit experimentally and imperfectly—the study of learner experiences of learning. It elicited information about learning and posited that studying CL in learners is a way of acquiring information also relevant to learning design. The phenomenological study serves as an example of the potential found in listening to learners with the goal of deepening understanding.

Essential Elements of the Conflict Between Expertise Transfer and Constructivism

For constructivists, instructors facilitate a cognitive process by motivating students and moving them forward (Seidel & Shevelson, 2007). In discovery learning (Kirschner, Sweller, & Clark, 2006) the least possible assistance to the learners is provided to learners when trying to discover the knowledge, allowing the learners to construct new knowledge, as much as possible, on their own. Cognitive psychologists claim this approach is detrimental because novice schemas are too under-developed to guide complex knowledge construction (Moreno & Park, 2010). CLT studies how cognitive resources are focused and applied to learning, and when cognitive activities are far removed from task goals, the resulting load impedes learning (Chandler & Sweller, 1991). The free explorations of complex classroom environments may overload the working memory and hurt learning (Paas, Renkl, & Sweller, 2003; Sweller, 1999, 2004), especially compared to more focused worked-example practice (Tuovinen & Sweller, 1999). Discovery and constructivist learning requires more mental operations and steps than an approach that offers more directive forms of guidance. CLT indicates that complex learning domains impose heavy loads on working memory and that these loads make learning more difficult (Chandler & Sweller, 1991; Kirschner, Sweller, & Clark, 2006; Paas, Renkl, & Sweller, 2003; Sweller, 1988; 1994). These findings were confirmed by novice teacher participants.

Catherine Doe shared an account of the expert help she was receiving in the class that strongly indicated such constructivist and discovery learning design. Her powerful beliefs about learning, trial and that learning be something she created in the classroom have already been indicated. In this passage, she was very explicit about the process, and the role of “trial,” “the mental test” and her “try” in coming to new knowledge.

> Interviewer: They give you advice then about what they want to see during that formal observation and then you integrate that?
>
> Doe: Mm-hmm.
>
> Interviewer: Does it ever make things easier, that advice they give you? Does it—?

Doe: Sometimes because they give you the starting point so that you don't have to think about where to start from. They give you what they want to see and then you have to figure how to put it there. And so sometimes if they don't give you the advice beforehand, then you kind of hope they like it [laughter].

Interviewer: [What] is that experience like then, integrating that extra thing or—?

Doe: I think it's fun. I like to try new things, so I enjoy it. I like to— even if it fails, it's fine because I know I'm trying it.

Interviewer: You seem to like the mental tests.

Doe: I do [laughter].

Interviewer: You do. Yeah. That's an awesome quality in a teacher.

Doe: I like learning and I like to get feedback. That's why I like teachers coming in to watch because I don't mind getting feedback about what I'm doing and how can I improve?

Interviewer: You just roll with it?

Doe: I try, yeah.

If Doe was given a starting point, she still was expected to figure out how to "put it there." Sometimes she was not even given the advice. She claimed to like it, because she "likes learning" and even if the un-described and unsupported strategy failed, it was all right, because she "tried" it. Here, the trial was itself the explanation. Things must be tried, without very explicit direction, in order for learning to happen. She associated the process completely with learning, a process she looked at positively. But she also claimed that the process only "sometimes" made learning easier, when they at least gave her a starting point. One may assume this type of learning was hard for failure seems expected, but accepted by Doe, who continues to try. It was uncertain how effective this learning process was, even though she said she liked learning in itself. There was much laughter during this explanation.

On the other hand, Gina Hunt could affirm,

> It's just the classic throw you into the water and they swim. "Figure it out." And it's just the only way to learn it is to just be submerged in it. Kind of like somebody who doesn't know a language, and they just drop you off in the country and say, "See you in a couple weeks." And it's not without really careful packing, and here's all your curriculum, and here's this beautiful building, and here's this beautiful master's degree. But essentially it's, "Figure it out." Nobody else can get inside your head but you.

To be tossed into a classroom, immersed in an environment with which one must interact without direction, was frustrating. Later, the researcher asked about her ideal learning design, and she affirmed this about the complex environment in which she had been immersed:

> Hunt: Number one, I believe that a novice teacher should have smaller class size.
>
> Interviewer: Okay.
>
> Hunt: And I think it should be a gradual build up. It shouldn't be throw you in with the average list of students.
>
> Interviewer: Decrease the complexity of a class.
>
> Hunt: Yeah. I think that if I could have mastered my first year with 15 students, the depth that I would have gained from that year versus having 30 students of all these complexities, I think I would have learned more. I think I would have mastered more. And I think I would have still been in the classroom just as the same calendar as all the other

> teachers, but I think that it would have drastically reduced the load and given me the ability to start my career with a foundation instead of a [inaudible].
>
> Interviewer: What's the foundation?
>
> Hunt: The foundation is just the depth. I think by June I would have had some real depth in my abilities versus like saying in June, "I made it." I don't think a first-year teacher should get to June and go, "Hoo, I made it." I think they should get to June and say, "I was made for this."

Hunt also affirmed that it was repetition of specific skills that she needed in order to grow as a teacher, being able to return to them.

> Interviewer: So what do you get? You get, "This is a skill you need to have," and then that's it?
>
> Hunt: Yeah.
>
> Interviewer: Okay. What would help you with that skill?
>
> Hunt: Follow up.
>
> Interviewer: I mean, you don't doubt the value of the skill. What would help you there?
>
> Hunt: Repetition, being able to go back to it more than once. So a novice teacher you're spreading yourself super wide and far. But imagine if you could just have a few more times in a certain area, you would be able to go a little deeper, a little better.

Kevin Long indicated the same, and contrasted this with his programmatic learning. The researcher had asked him earlier in this interview about drill and practice, and he used this reference in his explanation of his best learning design.

> The other thing I would say is in the actual classes that you're taking through a master's program or getting your teacher's license, whatever it is, a lot more on classroom management techniques and strategies that we've been talking about and actually practicing them like you were saying, like drilling them. Over that first summer, we had a lot of, "Here's how to plan and here's how to take your standard and break it down so that you have the essential questions you need for your lessons," and all that. And that's all great but you're not going to get there if you don't know how to first manage the class and set up the norms and set up the routines and figure out how you want to run things. If you want them to have a journal. So just a lot more—at least for me, if I were to have more during that summer of just how to deal with kids and practice that with even real kids. What kid wants to come into a college class in the summer? But having that kind of mock classroom like I was talking about where you're going to be able to think on your feet but in a more safe environment, I guess, if that makes sense. I think that would be a big help. And I mean, other than that, I think those are kind of the two things that I'm always coming back to. Like all of last year, I was like, "an, this would be so cool if I could teach it again next week."

The two elements in both accounts involve a change in environmental complexity that would presumably eliminate excess cognitive load and allow a teacher to focus on specific techniques. For Hunt, this was done by reducing class size, and for Long it involved a mock classroom. One could go a little deeper, learn to do a technique a little better. The second element was repetition. For Long it was not the nonrecurrent elements of lesson planning and backwards learning design that were needed, but the basic tools of classroom management, the norms and recurrent routines that allow a teacher to run things.

There was no single account of novice teacher trainers being concerned about cognitive load or excessive complexity, although, admittedly, the question was not explicitly asked. A lack of concern for classroom complexity and for the recurrent practices of teaching was indicated by several teachers. Based on beliefs about trial and error, time and experience (with experience being both a result of perseverance and “experiences” as classroom interactions), and the classroom as the best place of learning, as well as descriptions of reflective practice and the role of the coach as guiding learners through interactions to develop their meaning indicated strongly that their training was constructivist. There was also no sense from novice teachers that any other type of learning design was an option; it was simply accepted that teaching was learned in the way it was being learned. Learning designs included in the literature review are proved to reduce cognitive load. While teachers described having automated certain recurrent elements of practice and experienced benefits from such automaticity, that authomaticity was not indicated as having been designed or engineered. It seemed to have been perceived as simply a natural outcome of time and experience, trial and error.

Descriptions of cognitive load, the intention to make performances more immediate and available within the simultaneous environment, specifically to be able to notice or become actively aware of classroom happenings even as performances were carried out, very clearly delineated a hitherto unexplored goal for novice teachers. Teachers did not like their high levels of cognitive load, but the fact that “time” was necessary for learning indicated discoveries through trial and error were the only manner in which it might be reduced, not drill or scrimmage, as Lemov (2016) described and as CTA models of working with intrinsic elements of techniques recommends. The principles of complex learning apparently could meet the need of novices, if the need was recognized by their learning designers.

The Gap Between Novice and Expert Awareness.

The literature review described studies that alluded to differences between novice teacher and expert teacher cognitive architecture, the ways in which expert teachers draw on long-term memory schemas and have reduced their load. They cognitively perform recurrent complex classroom processes as though these were simple items. The literature review also explored studies of experts who are unable to describe the steps of complex processes due to being unconscious of these steps. In thinking of her own cognitive load and the demands the classroom placed on novices, Gina Hunt had much to say about her learning process that was negative, and also could critique her expert colleagues:

> Hunt: An expert teacher has already just adjusted. They're not interested anymore really. They've gotten so used to certain things. They don't pick those same battles. So novice teachers come in, we have the least amount of voice, but we also have the freshest take on it. It's almost like we come in and we go—we have this interesting thing to offer, but we have the least amount of voice. Whereas other teachers, they're kind of like, "You know what? We've been doing this for 10 years. Why fix if you can keep going?"
>
> Interviewer: You think more about each of the steps in whatever process to this because you have to, and they don't really do that.
>
> Hunt: That's the downside of, I think, becoming extremely automated is you're no longer picking things apart to that degree. Whereas a new teacher, because we have to, we're kind of going, "What in the world?"
>
> Interviewer: There is a downside.
>
> Hunt: And there's this very carnal—I think most of us—at least I was raised to respect my elders. It's like if somebody's older than you, you partly yield to somebody who's

> got age and experience, and they may know what they're talking about. . . . So there's also that sensation of—that makes you feel you need to be more silent in your own way because you know there's just this yielding thing that has to happen as a novice teacher, and that's an interesting feeling.

Her description of her own load, having to pick things apart, was contrasted with automaticity of experts. She primarily described a lack of voice as her major frustration, that what was happening within remained unspoken in the face of their experience, a powerful disconnection. Other teachers described a disconnection with their expert trainers, almost always in terms of what they were required to learn, as Kevin Long indicated above. Programmatic learning was of the complex and nonrecurrent variety, those elements of teaching that are the ongoing focus of expert learning such as backwards learning design, ways of differentiating specific instruction, elements of lesson plan that have categorical names but always have an ever-changing set of cognitive elements due to daily changes in lesson content. Expert teachers focused on what they themselves were still learning, the nonrecurrent, which novices repeatedly placed at a lower priority as they dealt with recurrent classroom challenges, such as classroom management problems that were endemic. Experts, it was repeatedly affirmed, were often out of touch with what was really needed to deal with the complexity.

Limitations

Limitations and problems with the study included, for the most part, several omitted questions the researcher wished he had asked. Questions associated with deficiencies of learning are a good example. Although all of the conversations had learning and problem-solving descriptions as the context, and teachers described the lack of performances or flaws in the steps of skills they were attempting to access, these questions could have pushed further. The researcher should have also asked, Does your cognitive load reveal to you your own learning deficiencies? If so, what is that like? This question very explicitly refers to the construct inefficient or extraneous load, and the researcher tied to avoid such firm directions in questioning. But, in retrospect, this exploration would have been fruitful. What the researcher called “real learning,” that performance or cognitive process that was immediate and available and that supported simultaneous practices and concurrent mental processes, could have been explored in the same way as well. This was a term arrived at based on the structure of descriptions and the explicit hopes expressed by novices regarding learning; teachers could have been asked more questions about the quality of learning, the explicit end result of learning processes for specific techniques. Teachers were still able to explore these end results in describing automaticity and expertise. The problem with both of the above questions for the researcher was that they required the very direct usage of expertise transfer categories and language, but if the study was replicated both elements of the experience could be deepened with more direct questions.

The study would be better extended with teachers familiar with some expertise transfer taxonomy and with teachers who have done focused studies on the cognitive steps associated with specific techniques. The gaps associated with working with teachers from a different design were helpful for the validity of descriptions, however. Teachers immersed in constructivist design were able to describe their mental workload with rich anecdotes, and give explorations of internal cognitive processes. However, it would have been helpful if teachers who had worked with the intrinsic elements of skills in isolated environments could discuss this experience, as well as compare it to the integration of such techniques in the complex simultaneity of the classroom. Such was not the learning design of these novice teachers. Novice teachers familiar with their own cognitive architecture, who understood and could distinguish how working memory and long-term memory interact, might have provided deeper insights. Cognitive load interviews should be aligned with the specific learnings and design of novice teacher much more closely. However, the phenomena of memory limitation and mental effort was still experienced and lived through and described in spite of this lack of background on the part of novices.

Implications of the Results for Practice, Policy and Theory

The researcher believes that all novice teacher preparation programs need to deepen their appreciation for the fact of CL and allow research in CL to impact their designs. Observation of novices should be observation of fluctuations in CL, but this demands a large element of subjective reporting, which means CL interviewing. Learning designers do not need to point out to novice teachers that they undergo CL, any more than firefighters in a burning house need to have conflagrations pointed out; the limits of memory and the liberties within their automated practices are known to novice teachers, for whom the classroom is always on fire. Navigation of cognitive load defines their lived experience. But conversations about CL give teacher-learners multiple directions of awareness of performances and mental processes, and would serve as a step to evaluating classroom learning needs. CL could be better understood and made relevant where it appears most constantly: in teacher learning.

Teacher learning design is in need of changes. Automaticity in support of recurrent complex performances in the simultaneity of classroom demands should be the goal of much of novice teacher practice. This latter would best be informed both by the literature of expertise transfer of complex learning and by novice teacher descriptions; skills hierarchies based on more refined taxonomies of performance must be developed by coaches and trainers and implemented to reduce cognitive load in order to make way for more complex learning. Expert coaches should not simply be promoted from years of classroom teaching to the role of coach without a thorough training in novice teacher learning design, including study of the difference in cognitive architecture and needs that novices present, the study of cognitive load. Novice teachers should be evaluated based on their levels of cognitive load, and evaluations of their learning should lead to better designs and selections of skills, as well as refinements of skills along the lines proposed by CTA. Constructivism, so helpful for experts who are giving meaning to nonrecurrent elements of teaching, has been embraced as the learning design for all of teaching; this is a flaw. Novice teacher learning design should lean more toward expertise transfer and the reduction of cognitive load in order to make way for the more complex learning that occupies expert teachers. Novices should be exposed to the latter only with the supportive learning of recurrent practices, only after the automation of the most simultaneous and concurrent mental processes and endemic problem-solving skills. Learning should be designed that increases mental space in working memory, and a skill set given that meets challenges and does not create struggle. Most problems of the classroom are problems of classroom learning design, and coaches must embrace this belief in finding solutions. Making this phenomenon relevant to teacher support and learning could be the most important step in ending our country's current dramatic attrition rates.

Recommendations for Further Research

Research on novice teacher cognitive load is still in its infancy. Its relevancy cannot be questioned by the researcher anymore, due to the ease with which novices identified the phenomenon, described its impact, and its pervasiveness in their lived experiences. This is the most relevant phenomenon in novice teacher learning, in the author's opinion. The literature review provided solutions. Teacher learning designs must include cognitive load as a relevant and informative phenomenon, and discover ways of utilizing it to improve expertise transfer and the building of long-term memory schemas. While CLT and CTA frameworks for such design will provide vital and essential resources, the phenomenological study of cognitive load and the utilization and development of the cognitive load interview also would provide powerful insights and new depths of understanding. Cognitive psychologists are currently exploring the measurement of cognitive load, but the interview as a tool has not been utilized. Novice teacher voices need to be heard. The place of teacher learning is the mind in its performances and utilization of resources, in its moment-to-moment cognitive processes; this is the place where the greatest adventures and triumphs of education occur, and teachers must develop a new language to understand and describe the depths of their lived experiences. This research was a source of wonder, and the singularity and uniqueness of classroom experiences cannot be exhausted with quantifiable measures or reified types of psychological constructs. Teaching is a massive and powerful adventure, and novice teachers learning to teach have many more insights to provide those willing to listen.

Conclusion

This phenomenological research achieved its purpose of exploring the phenomenon of CL through the lived experiences of novice teachers who were learning in the life-world of the complex classroom. CL is a profound experience, but understanding of this experience was deepened. The reflective exposition of rich descriptions and teacher insights regarding teacher CL appropriated new depth and demonstrated the great relevancy of this construct for teacher design. Novice teachers were allowed to tell their stories of practice in the moments of problem solving, their learning of recurrent classroom techniques, and explored how their enactment impacted cognitive processes, and new measures of awareness regarding their skills. The depth and specificity to be found in these singular and unique experiences should remain a source of wonder for further explorations of novice teacher learning.

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Appendix A: Interview and Observation Guide for Novice Teachers

Today's Date:
Place:
Time:
Interviewer's Name
Participant's Name:
Number of Months (Years) in the Classroom:

First Interview: Introduction and "Focused Life History"
Thank you for meeting with me. (Review Appendix E Consent Form and sign). Your participation in this study is totally voluntary and you may choose to withdraw at any time without adversely affecting your relationship with the investigator or Concordia University Portland. The District does not desire and will not review any of these interview recordings or transcripts or observation notes directly, and you will be given an alias when findings are presented. Your decision to participate will not result in any loss of benefits to which you are otherwise entitled.

(Audio Recording Begins)

Thanks for agreeing to be interviewed for this research. I view you as a "co-researcher" with me in this endeavor. What you share with me will help provide information that describes how new teachers experience their own cognitive processes.

While most teachers and coaches and students are concerned with what goes on in class and your action, I am interested in what happens in your mind, the "invisible circus" that may be happening, that is, your thought process or thinking. I want to understand how you navigate your classroom by having you describe in detail your mental processes.

To get a full picture of you and your stories, we will do three interviews. First, I would like you to tell me what it was like learning to be a teacher, your background. Then I will spend some time observing you in your classroom, hopefully in your most challenging class. Based on the observation, we will do an interview where you share "Details of Your Experience of Mental Effort in the Classroom,", or what you are thinking and experiencing as you teach the class. Lastly, I want to do a final interview to understand how you "Reflect on the Meaning" of your experience of learning to teach, and hear of similar experiences and how you think about them.

When I am done with these interviews, I will transcribe them, and then send you the transcripts to review. You can send me any comments after that.

Do you have any questions about what I've said or the purpose of the interview?

First Interview Questions: Focused Life History

> **Goal.** Build rapport and story-telling, practice accurate empathetic statements to move the conversation, establish the teacher's learning background, focusing on people and goals of learning, as well as prior learning experiences that are positive. Eliminate fear of

sharing in participants. Ask participants to talk as if the interviewer were someone else: "Imagine I was another new teacher." Ask them to tell a story. Follow up, listen carefully, but do not interrupt.

1. Did anyone inspire you to become a teacher?
2. What did they do that impacted you and your dream of being a teacher? Was there anything they could do effortlessly?
3. Do you have a teacher you really admire now and what do they do that makes them an expert, in your mind? Do you appreciate them more now that you are in your own classroom, and why?
4. At the university, you were in a classroom with a professor telling you about teaching; now, you are in a classroom environment, a complex place, and performing, doing it; describe the difference in your day-to day learning now.
5. What is learning to be a teacher like now that you are learning on your feet?
6. There are certain things in a classroom that you have to make happen or respond to in order to keep things moving. What are some recurrent goals and activities in your class that you have learned to easily deal with? How did you acquire that?
7. Tell me some things that always happen in the classroom that need a response. What challenges do you face in the classroom? Frustrations to your flow? What is helping you?
8. Do you ever practice or drill certain techniques? How do you acquire or improve on a new technique? When do you know that you have it down pat?
9. How does being in front of a class improve or complicate your practice? What type of interruptions to your decision-making and thought processes do you experience?

Tell me some things you currently are practicing in front of your class. Some things you are working to improve right now. What are the names of these techniques? (Your taxonomy.)

Is there something that you want to try with which you have not had much experience? (Possible Prompts: Radar / Be Seen Looking; Least Invasive Intervention; Firm Calm Finesse; What To Do; Positive Framing; Emotional Constancy; Wait Time; Circulate; Warm / Strict)

Isolation of New Skills for Observation

I want to schedule an observation of you in your class; it would be best if you did not try to choreograph everything in your lesson; I am not evaluating you, and, in fact, it would help the research study to be able to see everyday classroom problems and challenges to get at this experience we are exploring. I want to see you in your life, as you live through your class.

I also want to see you practice, in front of your class, that skill you brought up, the one you want to learn and improve. I would love for you to try and demonstrate it several times. Make this class a learning and practice experience for yourself. Remember, I am not evaluating you, just trying to get at your experience of learning new things in the classroom. I will be taking notes so the both of us can look at it later and have it serve as a reminder for you of what happened in class.

We can let the class know that I am not from the District and I don't work with the school, that I am another educator who wants to observe how I do my job, who likes watching teachers do their jobs, that I am learning about how to be a better teacher. I will sit in the back and they can pretend I am not there. I will observe your lesson from just before its beginning to a time after its end. I would also like to do the second interview in close proximity to this observation. What time and place shall we do these?

(Audio Recording Ends)

Today's Date:
Place:
Time:
Observation Protocol

Goal. Events and interactions will be audio recorded as they happen, and notes of visual events will be taken. Both the teacher and the classroom will be observed, with all events and responses having equal value. Recurrent practices and simultaneous happenings involving multiple techniques will be noted. Signs of stress or frustration, of a break in the flow of the lesson, of teacher heightened emotions, of a "stumble" or period of regrouping will be noted.

The entire purpose of observing teachers in this research is to support the interview process. The goal of observation is not to study teacher cognitive load directly, through observing teacher behaviors, but to help the teachers to identify and describe experiences in the classroom in depth that indicate fluctuations of their cognitive load. Hence, this study is not meant to test or confirm the effectiveness of a "cognitive load observation protocol". This protocol is simply designed to identify moments in a teacher's practice that might indicate levels of cognitive load. This observation protocol is unique in that it is targeting dynamic fluctuations in the cognitive load in the classroom. This study not only looks at cognitive load as a static measure of mental effort, but, as Feldon describes (7007a), a dynamically fluctuating experience. The theoretical construct explains a range of mental activity that moves from the working memory handling individual steps of an action laboriously, to the executing of a well developed schema of long-term memory unconsciously and without much thought involved.

The observation focus is not on just the teacher's mental state, but on meaningful activities of teaching, and the indicators of greater effort in the teacher's thought process associated with these. The meaningful items being practiced in this range are the same, and have the same level of complexity, but the teacher's mental workload is entirely different due to the level of schema acquisition. While cognitive load may seem a complex and obscure concept, it is also simple in that a specific level of cognitive load accompanies every classroom interaction, problem-solving event, and each attempt to acquire a non-automated task or technique.

For example, teachers undergoing higher levels of cognitive load will hypothetically require a heighted awareness of the steps of problem-solving, an increased focus that keeps them from performing simultaneous activities. Their mental processes will be more easily interrupted.

They may show outward signs of stress during enactment, or suddenly change their course or decision when a process overwhelms them.

The researcher will identify a meaningful activity and characterize that activity's execution.

Today's Date:
Place:
Time:

Second Interview Questions: Details of Your Experience of Mental Effort in the Classroom

Goal. Ask participants to "reconstruct" and not "remember". Attempt to elicit the prereflective experience of cognitive load; get teachers talking about working memory limits and their impact on their own acquisition of techniques; clarify the teacher's taxonomy relating to their own practice and its language.

(Audio Recording Begins)

Thanks for our first interview and the observation. I want to remind you that you were not being "evaluated" and that I consider you a co-author in this study of teacher mental workload. You're helping me to see what actually goes on. The stories you tell me and my analysis belong to you and me only, and your name will be anonymous in my analysis. In terms of introspection and thinking about and remembering your own thinking, I want you to dig deep here. I don't want you to tell me about what happened, or analyze it, so much as to tell me the story of what went on in your lesson, and your thinking process. Let's start by reviewing what happened (show video):

1. Lesson Review: Let's look at what you were doing at these (1-3) points in the lesson? What do you remember yourself doing? (Possible Follow-up Questions During Review: What happened when you did this? During a complex encounter… What happened here?What was that like? Some things here seem automatic, you didn't have to think about doing them, you just did them unconsciously. Here's what I saw… Tell me what I did not see at those times, what was happening in your decision-making and thinking. What was different about that technique or practice?
2. I got to see the outside of your teaching, but not the inside, your mental process. There were things you planned, things you had to notice and respond to. What was that lesson for you? When did it flow, what did you like? When did it not flow, and what did you dislike?
3. Finish these statements: when I do something automatically, I… When I do the thing I am still working on, I… (Be ready to elicit elaboration on feelings, student responses, self-image statements.)
4. You were constantly processing information in this classroom, sometimes a lot of it. At what points did you feel you had to process too much, too many decisions, or information? What was that like?
5. You said you were working on this item. Break the technique you are learning down for me, step by step, and don't leave any part out (How do you decide on this technique, how much, how little, when to focus on the next thing?). Tell me the story of that practice or

performance, what went on in your thinking… Write the script or story for me of what went on. How many of those steps do you actually remember doing as you did this?

6. When, during this lesson, did you encounter too much information? How do you know you had too much to think about? What were you thinking or feeling? Was your wheel-barrow ever too big; your tool-box too small? What other things were happening in the background when you decided to use this technique? What was it like, in your mental process, trying to perform this and having other classroom events and mental processes going on? Finish this statement: When this happened, I thought…
7. How much mental effort did the new technique(s) require, compared to the one you seem to do effortlessly? On a scale of one to ten, how complex was this activity while you were teaching the class? On a scale of one to ten, how much mental effort was invested in doing this technique at that moment?

(Audio Recording Ends)

Today's Date:
Place:
Time:
Third Interview Questions: Reflection on the Meaning

> **Goal.** To elicit the meaning that teachers give to their experience of classroom practice in the context of their own learning development. To elicit their own perceptions of the complex life-world of the classroom and the challenges associate with learning on their feet.

(Audio Recording Begins)

In our previous interview, you shared a lot with me how you experience the mental workload in your class while trying to practice new skills. In this interview, I want you to talk about that experience. I want to figure out how you interpret what happens in your classroom. Let's talk about that environment and your students in that environment, and how you see yourself learning to teach.

1. Is the classroom helping you or hindering you in your learning? What has working with students as you learn taught you. What is that like?

Examples of Complex Learning Environments (The researcher will read all three examples to the participant.)

Nursing. You are a novice Emergency Department Nurse in the emergency room; you have knowledge in medical procedures, but not a lot of practice. They are one nurse short on this shift, and you are by yourself in your own section. The Doctor is in his office finishing documentation and tells you to handle things on your own, he doesn't want to be disturbed. In one bay you are making a man comfortable who has been having mild chest pains; his wife is there and is very angry that the Doctor has not seen him yet, and you think the wife will begin shouting soon, increasing the husband's stress. In another bay, there is a girl crying who may have been the victim of a sexual assault; and the girl tells you, “I have got to get out of here!” You want to begin treatments you know are necessary. You have to calm down the wife, perform procedures for care of the husband, and make the girl feel safe as you also treat her. As you try to do the medical procedures, there are a lot of other things happening. The Head Nurse joins you, and calms down the woman with a couple of phrases as she hooks the husband up to some equipment and then you both go to the girl. As you dress the girl’s wounds with the Head Nurse, the Head Nurse lets the girl know she is safe with a gesture. All of this happens in the space of two minutes. The Head Nurse tells you she is taking a break and leaves for another part of the hospital. The wife starts to shout for help.

Air Traffic Controller. You are a young air traffic controller working with an older, more experienced one, in the tower. You both are in front of a screen that identifies planes, their different speeds and their altitudes, and the screen is always changing, adding new planes and giving new information. Multiple planes are approaching the same airport at different speeds and altitudes and your controller’s job is to redirect them. You marvel at the amount of data on the screen and you see a problem with the flight path of two planes. The more experienced air traffic controller glances at the screen filled with information about a dozen different planes, then talks to several pilots of several planes, giving them directions for approach based on safer trajectories, and as he talks, you notice that there were many more problems than you thought. You watch the problems being resolved in the correct order and in the correct way for several hours, marking changes in altitude and speed and trajectory brought about by the experienced co-worker. Then the older air traffic controller hands you the headset.

Platoon Member. You are in command of seven Marines and in an enemy’s territory, a large urban area with high-rise buildings. You have been ordered to clear the buildings. There are windows all around you that are empty of glass. There are noises coming from everywhere and civilians in the streets dressed in thick clothing, all watching you closely. The buildings are full of corners, tight hallways, open stairwells, and closed rooms with locked doors. There are suspicious objects lying on the pavement and in the hallways. You are listening to a headset that tells you of fighting throughout the city and troop movements close by. The soldiers under your command are looking at you, awaiting directions.

2. Do you ever feel that your job is like any of the ones I just described? What is that like? How complex does your thinking have to get; how much information comes at you in the space of an hour? What is the consequence of the amount of information and complexity on your learning?
3. In terms of teaching, could you be the expert in the story? How do you get there, how does it become easier? How will you know that you are the expert?
4. You are learning on your feet now. What hindered your learning in this classroom? What helped it? How is that learning on your feet impacted by your classroom’s complexity? multi-tasking? interruptions? information overload (as in too much happening)?
5. A lot goes on in a classroom. Things get busy. Have you experienced mental limits? Tell me about your mental limits in the classroom. What does it mean to you when you feel overwhelmed? What happens? What have you discovered about your limitations?
6. Are there things you wish you could do automatically, without thinking and what are those? What would they allow you to do?

7. How have experiences in your own classroom changed your view of learning to teach? Tell me those experiences.
8. (Remind teacher of confidentiality and the study's independence.) What is being supported like here? Who supports you now? Give me an example of what they do, those who teach you the art of teaching? What have you heard about your classroom techniques? Is it helpful? What is observation by experts like here; how does it feel? Does the expert advice demand more effort of you, or make things easier?
9. Based on what we have shared, what is your best learning design for becoming an expert?

(Audio Recording Ends)

Appendix B: Letter to Teachers Sent by Cooperating Districts

Dear Fellow Teacher:

Your first years of teaching are filled with powerful experiences. Your voice and your insights can provide insights that researchers need to develop support for first-year teachers.

I am a doctoral student in Teacher Leadership at Concordia University, Portland, Oregon, and I am in need of your help. I am hoping to learn from your experiences and your descriptions of life in the classroom as you are solving problems and learning new skills. Novice teachers, teachers with less than two years experience in the classroom, are learning on their feet. I believe that it is crucial for teacher preparation programs, coaches, and teachers to understand the inner life of the teacher, and how the mental workload they experience impacts teacher learning in order to provide greater support.

This research will involve three interviews, and I appreciate your time and effort and travel when you are having a busy year. For your time and effort and travel expenses, you will be given $30 per interview. Teachers who choose not to complete this research project will still be paid for the extent of their participation.

Please email me if you are interested in talking about my request for classroom observation and confidential interviews with you. My email is markvhebert@yahoo.com. My phone number is [Researcher email redacted]. I look forward to speaking with you.

This research will extend our knowledge regarding teacher practice, and I thank you in advance for your willingness to share your experience and contribute.

Sincerely,
Mark Hebert

Appendix C: Consent Form

CONSENT FORM

Research Study Title: Teachers Learning to Teach: A Phenomenological Exploration of the Experience of Cognitive Load with Novice Teachers
Principal Investigator: Mark Hebert
Research Institution: Concordia University Portland
Faculty Advisor: Dr. Marty Bullis
REFERENCE—Institutional Review Board #________________________

Purpose and what you will be doing. While problem-solving or practicing new skills in the classroom, new teachers will experience a range of levels of mental workload, sometimes as overload and frustration, other times as effortlessness and flow. I am conducting this study to understand the lived experiences of teacher mental workload among novice teachers. Sharing your experiences may impact how teacher educators design teacher development. You were selected because of your status as a classroom teacher of less than two years, and you are in the process of learning and problem-solving in a new environment. This research is being done for Doctoral Dissertation research purposes, and is not being done for any member of your District.

Procedures. If you agree to participate in the study, you will be asked to give three interviews regarding your experiences. I will ask you about your prior learning experiences (interview #1), accounts of your classroom experiences (interview #2), and the meaning you derive from these experiences (interview #3). These will be 60 to 90-minute personal interviews which will be audio-recorded. The recordings will be transcribed and I will also ask you to review transcriptions to determine accuracy. For the very specific reason of facilitating our conversation, I would also perform one classroom observation with a video recording for us to review. Interviews will be scheduled at a time and place of your convenience.

Risks and Benefits of Being in the Study. The study has the following minimal risks. First, in-depth interviews may bring up classroom experiences that may cause emotional discomfort, and you do not have to answer any questions you are not comfortable with. I will use pseudonyms for you and your school and district in publishing and presenting. I will work to de-identify reported information to maintain your confidentiality. All taped interviews and journal recordings will be secured in a locked file cabinet in my home office for your protection, and on a password protected computer. You will be provided a copy of the transcripts to validate accuracy. Any risk to you will be minimal as you are only disclosing personal information that you wish to disclose and you may withdraw from the study at any time. The data will be retained for three years and then destroyed; video- observations will be destroyed after the second interview. The information in this study may be published or presented and will be used in my dissertation, and there is a risk of "deductive disclosure", wherein you are recognized by a colleague because of situations you share. Again, I will work to de-identify reported information to reduce this risk.
In terms of benefits, the experiences you will provide will be invaluable, and will be contributing to the techniques that teacher-educators use to transfer expertise to novice teachers. Talking through your situation as a teacher may have practical benefits, as may looking at your current practice through a different lens. This could improve your teaching and the teaching of others.

Rights of the Participant. The questions are about your professional practice. Your participation in this study is entirely voluntary; you are free at any point to choose to withdraw from the study without penalty, and this will not adversely affect your relationship with the investigator or with Concordia University Portland or with your school district, and your data will not be used. You may skip any interview questions you do not wish to answer. There is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, I will stop asking you questions. You have the right to review your interviews and transcripts.

Confidentiality. Your experiences may be shared in the research report. Pseudonyms will be assigned at the beginning of this research to you, and utilized throughout this research to protect you and your school's anonymity. The records of this study will be kept private. Written, video and audio research records will be kept in a locked file cabinet in my home office. Digital video and audio-recordings will be uploaded to my personal password protected computer and erased after transcription. Only my dissertation advisor, Dr. Marty Bullis and I will have access to the data.

Waiver of Confidentiality Clause. There are only two reasons why we might have to give your name to a counselor or official. First, if we thought you were going to hurt yourself or someone else. Second, if during the course of the research I witness or hear of abuse or neglect of a child I will be obligated to report it immediately. Research information is not privileged, and may be subject to court subpoena. If you do not agree with our compliance of state law in this matter and are therefore unwilling to give this waiver of confidentiality, you will be withdrawn from the study.

Working with Children. The researcher will avoid any specific descriptions of students and student interactions and any descriptions of teacher student interactions will only use general descriptions, with no identifying information.

Remuneration

You will be offered remuneration for your time, effort and travel commitment in this research study, which involves three interviews. You will be offered $30.00 in cash per interview, immediately at the end of each interview. If you choose to complete this entire study, you will receive $90.00 total; however, participants receiving this total amount possible may still withdraw completely from the study afterwards without penalty or pressure from the researcher. This payment is prorated so that you may completely withdraw from the research at any time, even during an interview, and you will still be paid for your extent of participation, even if an interview is incomplete. You are required by law to report your remuneration to the IRS as income.

Dissemination. The information from interviews and observations belongs to both of us. You give me permission to use your words and to explore and analyze your experience. Your experience is the most valuable element of this study, and may be used in articles or presentations or other published venues. However, you will be given the opportunity to review and approve any material that is published about you. You can remove your permission to publish material you share by contacting Mark Hebert at [Researcher phone redacted] or [Researcher email redacted]. Because of potential conflicts of interest, no remuneration is offered for your participation.

Contacts and Questions. My name is Mark Hebert. You may ask any questions you have now. If you have questions later, you may contact me at [Researcher phone redacted] or email me at [Researcher email redacted]. You may also contact my advisor, Dr. Marty Bullis at (503) 493-6265. You may also contact the director of our Institutional Review Board, Dr. OraLee Branch (email obranch@cu-portland.edu or call (503) 493-6390). Or you may contact [Site information redacted] if any concerns or complaints arise regarding this study. You will be given a copy of this form to keep for your records.

Statement of Consent:
I have read the above information. My questions have been answered to my satisfaction. I volunteer my consent for this study. I give permission for observations of my teaching practice and audio taping during interviews.

____
Name of Study Participant

____ _____________
Signature of Study Participant Date

Mark Hebert
Name of Researcher

____ _____________
Signature of Researcher Date

Investigator: Mark Hebert
c/o Professor: Marty Bullis
Concordia University–Portland
2811 NE Holman Street
Portland, Oregon 97221

Appendix D: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously- researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

> As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does "fraudulent" mean?

> "Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate's final work without full and complete documentation.

What is "unauthorized" assistance?

> "Unauthorized assistance" refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (Continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University- Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*

Mark Hebert

Digital Signature

Mark Hebert

Name (Typed)

November 10, 2018

Date