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Intentional Depth of Knowledge and its Effects on K-12 Student Engagement

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A Dissertation Submitted to

The Faculty of
The Annsley Frazier Thornton School of Education
Bellarmine University
In partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Education and Social Change

May 27, 2015

Dissertation directed by

Dr. David D. Paige
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The Annsley Frazier Thornton School of Education and Bellarmine University certifies that John M. Sizemore has successfully defended her dissertation for the degree of Doctor of Philosophy in Education and Social Change as of May 27, 2015. This is the final and approved form of the dissertation

Intentional Depth of Knowledge and its Effects on K-12 Student Engagement

John M. Sizemore

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Dedication

This research is dedicated to hard working teacher and school leaders seeking to find additional ways to increase the effectiveness of the profession. Educational professionals work laboriously to find the schema which will motivate a student to be more effectively engaged in the learning climate. Leaders go through a plethora of programs seeking solutions. This research, while not discounting the value of programs, encourages teachers to look within their own planning processes to find pedagogical solutions which move students through a hierarchical process of cognitive complexity and student engagement.

I also want to dedicate this to the student who though from a background of poverty or otherwise underserved populations, does possess the ability to think at high levels and can compete effectively with others including those fortunate to be in families with higher SES levels or otherwise privileged conditions. This research indicates the connection between student successes or poor performance rests solely with the sophistication of the teacher to be able to deliver a cognitively complex lesson to all students at all educational levels.

Finally, this research is dedicated to those hard working professional who want to go beyond current data platforms to root out the conditions which are between those being less successful and the ecstasy of thinking at high levels with the corresponding feeling of success.

Acknowledgments

The patience of family through this process has been so important. Grandchildren who were looking to learn to hit a ball, feel the pain of a skinned knee in learning to ride a bicycle or listening to them read a picture book have been compromised. Chats with others in a lazy summer evening or the comfortable warmth of a fireside chat have been compromised through this process. To my family patience was sought and gained through the pursuit of a Ph.D, albeit for personal reasons.

My dedication to a career in education and the lingering pursuit of questions were inspired by my mother with a determination toward a semblance of excellence from my father. Acknowledging their contribution to the pursuit of my doctorate is absolutely necessary. To them I owe the thirst for learning and knowing that we receive our blessings only through our dedication to others.

There are times through this process you may lose hope. Hope may be regained from enduring the weight of divergent roadblocks or more quickly and with greater impact by having people who continually encourage you to stay focused on the goal. My committee has been instrumental in keeping me focused; moreover they have instilled a sense of hope and determination toward a final product. I want to fully acknowledge how important they have been in the work and wish to make it not my work, but a team effort which has resulted in a product that may incite ideas in others.

Abstract

This research study attempted to identify the impact that cognitive complexity has on student engagement. The primary research questions asked were: What are the effects of depth of knowledge and learning mode on student engagement? Are there interaction effects among depth of knowledge and learning mode and what impact does the interaction have on student engagement? And, are there any variances in interaction effect by educational level (elementary, middle or high school) for depth of knowledge and learning mode on student engagement? This study attempted to determine if cognitive complexity of learning using depth of knowledge (DOK), and learning mode (LM) as measured by whether students were working alone or with others, were catalysts to increasing student engagement. A common walkthrough instrument was used across all grade levels K-12 to collect the data. Data analyses did indicate that DOK was a factor in increasing student engagement across all levels and that the interaction of learning mode resulted in improvement in student engagement across the broad K-12 setting. However, when broken down by educational level, while DOK consistently increases student engagement, the data indicated that the interaction of DOK*LM and LM were significant in increasing student engagement at the high school level. At the elementary and middle school neither LM nor the interaction of DOK and LM had an impact on increasing student engagement. The research results indicated LM operates in a supportive fashion to DOK.

Key Words: rigor, cognitive rigor, cognitive complexity, engagement, student engagement, disengagement, behavioral engagement, psychological engagement, learning mode, learning alone, learning with others, Bloom's taxonomy, depth of knowledge

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Chapter One: Introduction

Statement of the Problem

Of the 275,000 students who completed the High School Survey of Student engagement from 2006-2009, at least 65% reported being bored in school at least one class a day while 16% indicated being bored in each class (Cooper, 2014; Yazzie-Mintz, 2009). Goodlad (1984) suggested boredom may be the most pervasive reason for lack of student classroom engagement, especially at the high school level. Research has suggested that motivation is an essential factor relating to student engagement, but it is only within the last 30 years that the relationship between cognitive complexity and engagement has been considered to address motivation and achievement in the classroom (Appleton, Christenson, & Furlong, 2008; Dweck, 2004; Deci & Ryan, 1985).

Student achievement indicators continue to confirm that all students do not achieve appropriately (Aud et al. 2010; National Center for Educational Statistics, 2011). Academic outcomes vary differently by socio-metrics (gaps in learning between identified populations) are now 30% to 40% greater than just 25 years ago (Reardon, 2011). Other evidence suggests that little progress has been made over the past three decades in both reading and mathematics achievement for students in general (Lee, 2010).

State and federal accountability mandates require improved student achievement through the implementation of standards that specify cognitively complex learning tasks (Walkup, 2014; Supovitz, 2009; Murphy & Schwarz, 2000). Bempechat and Shernoff, (2012) relate the serious consequences of underachievement and school disengagement at the individual and societal level. It is not our curriculum that is the problem, but the instructional pedagogy offered to our public school students that is problematic in changing achievement scores (Stossel, 2006).

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The relationship between an engaging classroom pedagogy and student achievement has been studied in kindergarten through high school settings (Pointz, Rimm-Kaufmann, Grimm, & Curby 2009; Gredriocks, 2011). When increasing the complexity of the learning tasks, student engagement increases (Walkup, 2009; Nakamura & Csikszentmihalyi, 2002; Marks, 2000; Deci & Ryan, 1985; Csikszentmihalyi, 1990) resulting in improved student achievement (Pointz et al. 2009; Gredriocks, 2011). Educators generally view the ability to assess cognitive complexity of classroom requirements with two different, but related, theoretical perspectives through Bloom's taxonomy [Bloom, Englehart, Furst, Hill, & Krathwohl, (Eds.) 1956] or Webb's Depth of Knowledge (Webb, 1997).

The challenge of engaging students in complex classroom learning tasks is dependent upon teachers having the proper instructional and pedagogical competencies. Murphy and Schwartz (2000) stress that instructional skills such as the collection and analysis of data as well as using data results to inform academic and pedagogical direction improves achievement outcomes.

Teachers acknowledge that the work students are asked to do in the classroom is far different from what teacher training programs prepared them to deliver (Stossel, 2006; Wagner, 2006). Wagner (2006) indicates there is a substantial disconnect between the work a student is asked to do and what teachers believe are rigorous classroom tasks. Wagner stresses that when teachers cover materials at a faster pace and with higher order questioning or tasks, learning results. Cognitively challenging work requires a student to think and increases student engagement.

Curricula with embedded thinking-based learning and a resulting high level of engagement are successful in creating a quality learning environment (Blackler, 1995; Drucker,

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2001; Schlechty, 1997; Zuboff, 1988). The challenge for teachers is to rethink teaching by moving the learning environment from isolated random acts of excellence to a larger generalized learning environment that prepares students for work, citizenship and continuous learning experiences in a new electronic society (Wagner, 2006). The move to thinking-based classrooms characterized by an emphasis on higher order thinking, students learning with others, and high levels of student engagement invigorates a student's classroom learning experience in line with Wagner's notion of 21st century learning (Fredricks, Blumenfeld & Paris, 2004; National Governors Association Center for Best Practices and the Council of Chief State School Officers, (2009).

Several authors have called for a redefinition of cognitive complexity and engagement through observation of the work or activities engaged in by the student (Schlechty, 2011; Dweck, 2006). The research indicates that student engagement measures already exist – such as classroom walkthroughs, data analysis, peer coaching, and focused lesson development, etc. Research suggests that these tools assist in analyzing and creating an engaging classroom and learning culture (Easton, 2009; Marzano, 2003; Marzano & DuFour, 2009). By considering student engagement, whether students are learning independently or with others (learning mode) and with the extent to which higher order thinking is required, the notion of cognitive rigor or complexity is broadened (Christenson, Reschly & Wylie, 2012).

Researchers are now suggesting that teacher pedagogy should encourage an environment that enables students to work collaboratively in order to equip them with 21st Century skills (Shernoff, 2013; Wang & Eccles, 2013; Downer, Rimm-Kaufman & Pianta, 2007). Current views of learning challenge traditional pedagogical practices by inspiring the learner to take a more active role in the lesson (Skinner, Kindermann, Connell & Wellborn, 2009; Dufresne et al.

1996). Schlechty (2002) further suggests a relationship exists between collaborative learning and student engagement.

Purpose of the Study

This study will investigate the extent to which the thinking level required of students to complete learning activities effects their classroom engagement. Through a sampling over time technique (Deming, 1993) that is focused on the learner, classroom learning tasks are observed to determine the thinking level required of the student, accompanied by the degree to which students are engaged in the activity. The resulting data will suggest the extent to which classroom engagement is effected by the thinking level engaged in by students. The research questions guiding this study are:

Within each of the three building types (elementary, middle and high schools)

1. What are the effects of depth of knowledge and learning mode on student engagement?
2. Are there interaction effects among depth of knowledge and learning mode and what impact does the interaction have on student engagement?
3. Do the effects of LM and DOK on engagement vary by educational level?

Significance of the study

The effect of depth of knowledge on student classroom engagement has not been previously researched using Webb's DOK (1997). The proposed research focuses on measuring the intentional use by teachers of Webb's Depth of Knowledge (DOK) as well behavioral indicators of student engagement. Research indicates that teaching excellence leads to the use of higher order thinking skills and high student engagement (Tharp, 2012; Vygotsky, 1978;

Bronfenbrenner & Morris, 1998). However, the effect of DOK on student classroom engagement has not been previously researched.

Conceptual Framework

Cooper and Garner (2012) describe the classroom learning environment as a process of moving interactively through the cognitive rigor process of lower to higher order thinking and vice-versa, to garner learning momentum. When students are substantively and deeply engaged in learning, it is akin to being in the flow of the classroom experience (Csikszentmihalyi, 1990). Csikszentmihalyi likens classroom flow to the athlete being consumed by the action of the game or the dancer immersed in the performance. This flow state is encompassing; individuals function at their fullest capacity with the learning experiences being the reward (Schlechty, 2011; Schlechty, 1997; Csikszentmihalyi, 1990; Deci & Ryan, 1985; DeCharms, 1968).

Csikszentmihalyi (1990) describes the highest level of this state of flow as being an optimal experience. At this level the experience has moved from mere behavioral engagement to one of being in a state of psychological engagement and completely consumed by the interaction of challenge and skill and may be disassociated with all others except the learning or challenge.

Linnenbrink (2007), Linnenbrink-Garcia, Rogat, & Koskey (2011) and Linnenbrink & Pintrich (2004) indicate only the outward characteristics of the student can be assessed in determining an engaged learner. In other words, engagement can be determined by observing the student's behavioral participation. The engagement emphasis is on the quantity of those appearing to be engaged rather than an emphasis on the quality of engagement (meaning students who are psychologically engaged) (Fredricks et al. 2004; Pintrich, 2000).

This work is intended to be a behavioral engagement study only.

Summary of Methodology

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This research is based on data gathered using an analytic sampling technique (Shewhart, 1931) that is based on the law of large numbers and composed of walkthroughs conducted in K-12 classrooms. In an analytic sampling technique, the universe to be observed, classrooms across a school district in this case, is divided into rationale subgroups. Samples are then obtained from each of the subgroups to estimate the behavior of the variable(s) under consideration across each of the subgroups. Reducing the time spent in the classroom during each visit and conducting multiple walkthroughs dispersed over the school day and week provide a more thorough perspective of the quality of learning occurring in the school building (Paige, Sizemore & Neace, 2013). The focus of each walkthrough is to determine the cognitive complexity of the work as determined using Webb's Depth of Knowledge (1997, 1999 [DOK]), the percentage of students behaviorally engaged in such work, and whether students are working independently or with each other, a variable called learning mode. To assist with the gathering and storing of over 2,000 observations, a web-based data collection system was employed (Paige et al. 2013). The instrument utilizes a drop-down menu for each of the observed variables which include teacher pedagogy, grade, learning mode, DOK, total students in the class, and the number of students who are not engaged. The classroom cognitive and engagement data are gathered on a web-based platform that uses a drop-down menu checklist. The information is collected on a server for later analysis. Each of the walkthroughs is brief, usually less than one and a half minutes in duration.

An analysis of variance (ANOVA) will be used to analyze the relationships and potential interaction effects between depth of knowledge, student engagement, and learning mode. The interaction effects will be determined using a 2 by four 4 factorial analysis of variance of classroom depth of knowledge and learning mode. The dependent variable of interest is student engagement while there are two independent variables, depth of knowledge and learning mode.

Limitations

There are several limitations that affect the generalizability of this study using the Student Engagement Rating Scale for the Classroom (SER-C) data collection system. SER-C is a web-based walkthrough instrument for collecting cognitive rigor and student engagement. In a walkthrough the observer is only gathering brief behavioral engagement data. It is acknowledged that situational variations in the learners or classroom can affect ratings and as such may not be representational of routine classroom instruction. Observers also create an “other” in the classroom and can affect the authenticity of teacher performance.

Inter-rater reliability checks were conducted and further monitoring of the consistency is monitored through periodic review of consistencies among those in the school that are completing the walkthroughs. When there appeared to be major coding deviation for DOK and engagement, contact was made with the site leader to recommend additional training.

Student engagement, for the purpose of this research, is the level at which a student is behaviorally engaged with classroom instruction (Christenson, Reschly, & Wylie, 2012; Csikszentmihalyi, 1990; Deci & Ryan, 1985, 2000; Yazzie-Mintz, 2009; Webb, 1997). There is no determination made or even attempted to determine psychological engagement.

Additionally, using Webb’s DOK levels the highest cognitive complexity label is DOK 4 and labeled as “creating”. At this level of complexity a student is typically working alone in an activity such as writing an original score, creating an original piece of art, writing a composition, etc. Thus what is classified as inappropriate student behavior or disengagement might in actuality be a high level of DOK.

Finally, the size of the school district (four schools) and the geographical setting (rural farming area) restrict generalizability to a larger, more urban school districts and settings.

Definition of Terms

Cognitive complexity or rigor refers to the individual relationship between the learner and the teacher's learning concept being presented and needs to be thought of as learning which is engaging, compelling, and active (Schlechty, 2002). When combining student engagement, learning mode and higher order thinking, the notion of cognitive rigor is broadened (Christenson et al. 2012). In thinking of cognitive rigor, how students learn and engaged appear to be important constructs that support the joy for student learning (Shernoff, 2013; Csikszentmihalyi, 1990). Cognitive rigor or higher levels of DOK can be thought of as a continuum or taxonomy defining the type of mental processing required of the student by the learning activity (Webb, 1997; Bloom et al. 1956).

Learning mode describes the collaborative nature of the student work by identifying whether students are working alone or with others. Working alone is construed as low level cognitive complexity or considered a DOK 1. Working with others is generally described as higher order or be DOK 2-4 on Webb's taxonomy scale. See Appendix B for the complete Depth of Knowledge DOK descriptors.

Chapter Two: Literature Review

Researchers and educators have become increasingly focused on student engagement as an important factor in addressing low achievement, boredom in the classroom, and high dropout rates (Archambault, Janosz, Morizot, & Pagani, 2009; Finn, 1989; Fredricks et al. 2004). This literature review will examine cognitive complexity in particular, Webb's depth of knowledge (DOK) levels, student learning mode defined as either independent or collaborative learning, and student engagement research.

Theoretical Framework

Csikszentmihalyi (1990) describes the notion of optimal experience as one where the individual is in control by directing all their actions to the point where they feel completely assured of achieving their intended outcome. Optimal experience is encompassed within the theory of flow, a state where the individual is engaged in an activity they find completely absorbing (Csikszentmihalyi, 1990). Hence, flow is defined as "the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" (Csikszentmihalyi, 1990, p. 4). When in a state of flow, the individual not only perceives the activity as enjoyable, but as something worth doing, even if it is quite difficult (Nakamura & Csikszentmihalyi, 2002). In order for the individual to attain the state of flow, three conditions must be present (Csikszentmihalyi, 1990). First, there must be interest in the activity and secondly, the participant must bring focus and concentration to bear on the activity. Lastly, the individual must find the activity enjoyable. With these conditions in place the activity becomes its own reward and provides intrinsic satisfaction to the individual (Csikszentmihalyi, 1975; Deci, 1975; Deci & Ryan, 1985). Because the state of flow is so highly rewarding, its replication is sought by the

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individual, providing a natural mechanism for scaffolding ultimate growth and competency of the desired activity, skill, or competency (Nakamura & Csikszentmihalyi, 2002).

For individual growth to occur, challenge of the activity must be properly matched with the skill level of the individual. The zone of proximal development (Rogoff, 1990; Vygotsky, 1978 [ZPD]) provides a framework for viewing how skill level and challenge are matched to potentially produce a flow activity. Within the ZPD the learning task must be beyond the current skill level of the learner, but not so difficult that it is beyond the learner's developmental reach. Once the learner becomes competent with the new level of challenge, the difficulty of the activity can again be increased so as to be just beyond the learner's present state of competency, but again, within developmental reach. Effective scaffolding using the ZPD is that which best helps the learner to internalize the desired skill or knowledge (Puntambekar & Kolodner, 2005).

The state of flow has been found to be related to student engagement where intense focus on an activity brings new learning (Csikszentmihalyi, 1990). An example can be found in a longitudinal study of tenth- and twelve-grade students randomly selected from thirteen high schools across the United States. Over the course of a week students were randomly signaled up to eight times by an electronic pager. At each signaling the student stopped and completed in a logbook answers to a survey where they reported on their current location and activity, as well as on various aspects of their engagement forming constructs for anxiety, relaxation, apathy, and flow. The authors found that when students perceived a high challenge, engagement was high. Also, when students perceived their personal competency or skill with the learning activity as high, engagement was also high. However, the highest levels of engagement occurred for the interaction of challenge and skill. Further analysis using attention rather than behavior as the dependent variable found similar results where students in the flow condition reporting paying

attention 73% of the time. Overall results of this study found support for the flow theory and the notion that when in flow, individuals are likely to be engaged and focused. The authors also found that students working independently can be equally engaged as those working cooperatively.

Cognitive Complexity

The National Commission on Excellence in Education was established in 1983 with the purpose of studying America's educational system. It was determined that America's schools were not only falling behind other industrialized countries, but were graduating students unprepared for a changing labor market that required workers to problem solve and use current technology (National Commission on Excellence in Education, 1983). The Commission exposed an educational system failing to establish a rigorous learning environment where students are asked to think and engage with content at higher levels of cognitive complexity (Schlechty, 1997).

The Commission's report (National Commission on Excellence in Education, 1983) created a sense of urgency for researchers and practitioners alike to explore ways to engage student in classroom learning. The report emphasized instituting a more cognitively complex curriculum with increased student engagement (Finn, 1989; Finn & Rock, 1997; Fredricks et al. 2004; Fredricks et al. 2011; Newmann, Wehlage, & Lanborn, 1992).

Strong, Silver, and Perini (2001) suggest cognitive rigor or complexity in the teacher's lesson delivery helps a student develop the capacity to understand difficult subject content. However, educators tend to emphasize student engagement more than cognitive rigor in defining a well-functioning classroom (Metropolitan Center for Urban Education, October 2008; Cushman, 1995). While teachers were creating experiences that transformed classrooms into

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learning environments that were active, compelling, motivational, and engaging, classroom observations revealed the percentage of classrooms where students were asked to think at high levels was very small (Glasser, 1990; Goodlad, 1984; Oakes, 1985; Prince, 2004; Schlechty, 1997; Sizer, 1984, 1992; Steinberg, 1995; Wagner, 200). Public school learning environments were characterized as places where students were merely being compliant and asked to do low level cognitive thinking antithetical to knowledge work that is engaging and active (Schlechty, 1990, 1997).

Higher order thinking is operationally defined as the process by which a person takes new information, connects it to an existing cognitive schema, and extends the information for a new purpose or application (Lewis & Smith, 1993). Blackburn (2008) considered such higher order thinking or cognitive complexity as a necessary consideration in the order and structure of a lesson; the teacher strategically moves a student through a thinking hierarchy to cognitive complexity. Higher order thinking in a classroom activity is referred to in the literature as the cognitive rigor of classroom work. Because cognitive rigor is a goal for all students, a teacher must use a wider range of teaching strategies to engage each student in the lesson (Mueller & Chair, 2006).

Cognitive rigor implies the movement from lower level to higher level thinking. Cognitive rigor is more descriptive of the complexity of the curriculum guiding a classroom lesson (Hess, Jones, Carlock, & Walkup, 2009). Some see increasing rigor as a function of teacher pedagogy (DuFour, DuFour & Eaker, 2010; Hess, 2006b; Hess et al. 2009; Marzano, 2003) while others see cognitive rigor as a function of an academic emphasis, sometimes referred to as “academic press” (Bowers & Powers, 2009, p.1). The value of academic press is

emphasized in a statement by Shouse (1996) where “Academic press stands as a statistically significant predictor of school achievement” (p. 61).

Others describe cognitive rigor more holistically as a classroom with high expectations, clear academic goals, rigorous classroom work and equally purposeful homework; all elements essential in promoting academic press (Early et al, 2014; Fredricks, 2011; Martin, 2009; Phillips, 1997; Yazzie-Mintz, 2007). Researchers’ suggest the lack of higher order thinking in American classrooms is due to the absence of concrete pedagogical examples or classroom curricula with designed cognitive complexity (Fredricks, 2011; Martin, 2009; National Research Council and Institute of Medicine, 2004; Shouse, 1996).

Throughout the literature there are variations of the definitions given to the terms cognitive complexity, such as cognitive rigor, cognitive engagement, and higher order thinking. Cognitive complexity is described as the student’s movement through rigor levels (per Webb’s DOK levels) within the context of a lesson (Hess et al, 2009; Jones, 2014). Cognitive rigor is a holistic description of work in which the student may engage during a class lesson (Blackburn, 2008). Higher order thinking is more characteristic of Bloom’s taxonomy and describes the expected level of a lesson or the thinking level the learner should reach during the class lesson (Anderson et al. 2001; Bloom et al. 1956). Cognitive engagement is observable when the learners are in sustained, engaged attention to a task requiring mental effort; and authentic, useful learning is produced by extended engagement in optimally complex cognitive activities (Stoney & Oliver, 1999).

Ladwig, Gore, Amosa, and Griffiths (2007) explored student motivation and engagement as necessary components in cognitively complex tasks and learning. Stoney and Oliver (1999) suggest that cognitive engagement and student motivation are linked together through mental

representations, monitoring, and evaluation of responses and strategic thinking. The data were drawn from the Systemic Implications of Pedagogy and Achievement (SIPA) in New South Wales (NSW) Public Schools (Software Industry Promotion Agency, 2004). The schools studied represented rural and urban, high, middle and low socio-economic status (SES) students from primary and secondary schools. The student work samples were drawn from students in grades 4, 6, or 8. Student work samples were analyzed at six (6) points in each school year over a three-year period. When analyzed, student work samples generally represented low level rigor or cognitive complexity.

Hess et al. (2009) conducted another review of the collected student work samples and found low level cognitive rigor equated with simplistic student tasks and requirements. Teacher practices and questioning strategies generally lacked complexity and depth (The Standards Company, LLC, 2008a, 2008b). The results of the study New South Wales (NSW) Public Schools (Software Industry Promotion Agency, 2004) study indicate that cognitively complex instruction was a challenge for teachers (Software Industry Promotion Agency, 2004; Ladwig et al. 2007). The research did indicate that when a school was involved in instructional pedagogical initiatives, high quality and cognitively complex teaching practices resulted.

Cognitive complexity or higher order thinking is not to be confused with the Higher Order Thinking Schools (HOTS) project developed by Pogrow (2004). Higher order thinking skills include these descriptors: critical, logical, reflective, metacognitive, and creative thinking. Some or all of these must be present in describing an activity to stimulate higher order thinking where the task presents unfamiliar problems, deep questions or clear solutions (King, Goodson, & Rohani, 1998). Higher order thinking refers to activating student schemas - the skill and ability to organize memory knowledge in ways useful in solving problems (Pellegrino &

Hilton, 2012). Higher order thinking skills are grounded in lower order skills such as discriminations, simple application and analysis, where cognitive strategies are linked to prior knowledge of subject matter content.

The theories of Dewey (1902) greatly impacted education in the last century through his call for student-centered and challenging classroom work. Dewey envisioned a curriculum rich in critical thinking and balanced connections with culture and knowledge. However, it was not until much later that taxonomy was offered to educators by which cognitive complexity could be measured (Bloom et al, 1956).

Bloom's taxonomy.

Bloom extended Dewey's theories by creating distinct taxonomy levels (Bloom et al, 1956). This hierarchy enabled educators to rate student classroom requirements from simple recall to the highest level of synthesis, as well as to write instructional objectives for classroom learning at an identifiable taxonomy level. Revising Bloom's taxonomy in 2001 allowed for a multidimensional process to be added with the taxonomy adding cognitive processes as a dimension along with knowledge (Anderson et al. 2001).

Bloom's six taxonomy levels offered educators a structure for curriculum planning and student work based on cognitive complexity and higher-order questioning (Walkup, 2008). Student responses to higher-order questions help assess their genuine understanding of academic content. Additionally, the ability to answer and assimilate higher-order questions gives the student confidence and the ability to communicate knowledge regarding complex issues (Hess et al. 2009). The value of Bloom's taxonomy for educators is that it offers an organizing dimension helping teachers plan and deliver instruction as well as offering a structure for designing learning objectives and assessment tasks (Anderson et al. 2001).

Webb’s depth of knowledge.

Bloom’s taxonomy was very useful but educators wanted the learning climate to be more dynamic and inclusive of other factors in a student’s successful engagement like motivation, personal interest and disciplined learning (Deci & Ryan, 1985; Finn, 1989). Webb’s Depth of Knowledge (DOK) was developed in 1997 as a refinement and reconceptualization of Bloom’s taxonomy. Webb’s cognitive taxonomy has four levels and creates for educators less choice and clearer, more consistent predictability in determining levels of cognitive complexity for the learner (Hess et al, 2009). The most discernible difference between the Bloom and Webb taxonomies is that cognitive thinking levels are related to the learning in Webb’s cognitive rigor continuum (See Table 2.1)

Table 2.1

Rigor Level Comparisons of Bloom and Webb

Rigor Level	Bloom’s	Webb’s DOK
Low	Remember, understand, apply	Recall, apply
High	Analyze, evaluate, create	Strategic thinking; Extended thinking

Generally, Bloom’s taxonomy applies a fixed value for a given standard or objective while Webb’s DOK describes the different levels at an expected DOK and is more fluid or process oriented (Dweck, 2006).

A Partnership for 21st Century Skills (2002) by a coalition of governmental organizations and private industry, initiated a national conversation about the importance of an array of knowledge, skills, work habits, and character traits that are vital to learners. The group identified an essential set of skills learners should possess such as critical thinking, problem solving,

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reasoning, analysis, interpretation, synthesizing information; better described as cognitively complex thinking essential to lifelong learning. These skills, with such descriptors as imagination and creativity, cooperation, analytical thinking, etc., were not likely taught, measured or assessed (Rotherhan & Willingham, 2009). Webb's (1997) Depth of Knowledge taxonomy was endorsed by many state education officers (Wilhoit, personal communication, June, 2013). Using DOK to guide student learning enables a teacher to move from assessing the behavioral objective to assessing the degree to which the student is cognitively engaged in complex learning.

Webb's taxonomy divides learning into four distinct levels (See Table 2.2). Level 1 (Recall) is based on the learning of facts, may require only one step, and include identifiers such as recall, recognize, use, identify, list, or calculate. At Level 2 (Skill/Concept), students are asked to engage in thinking beyond recall. They may be asked to summarize, collect, organize, display, compare, observe, or estimate. At Level 3 (Strategic Thinking), students must reason, use evidence, generalize, connect ideas, infer, or apply a concept to a new setting. Level 4 (Extended Thinking), requires students to be able to create new structures, new thoughts, original documents, etc. This will likely include extended activities in which students analyze or synthesize information from multiple sources, analyze common themes, use several variables, conduct an investigation, develop a logical argument, etc. (Webb, 2002).

Table 2.2

Webb's Depth-of-Knowledge Taxonomy

Level	Descriptor
DOK-1	Recall — Recall a fact, term, principle, or concept; perform a routine procedure. May have one widely accepted answer.
DOK-2	Strategic Thinking — Reason or develop a plan to approach a problem; May require multiple disparate sets of data stimulating

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	some decision-making and justification; solve abstract, complex, or non-routine problems, complex.
DOK-3	Strategic Thinking — Reason or develop a plan to approach a problem; May require multiple disparate sets of data stimulating some decision-making and justification; solve abstract, complex, or non-routine problems, complex.
DOK-4	Extended Thinking — Perform investigations or apply concepts and skills to the real world that require time to research, problem solve, and process multiple conditions of the problem or task; perform non-routine manipulations across disciplines, content areas, or multiple sources.

The teacher's role is leading learning and classroom activities using pedagogy and tasks described as cognitively complex using higher levels of DOK. The teacher facilitates the learning process rather than just dispensing knowledge; this is very similar to what is known as the medical model of training (as cited in Beck, May 2004). The focus of the teacher is transitioning from the teacher limiting the level of discussion and knowledge to that of creating a learning arena where students work collaboratively in solving problems and extending the learning, thus enhancing analytical critical thinking to being problem solvers and gaining mastery skills in communications (Schlechty, 1997).

Understanding by design.

While not used as extensively as Bloom's Taxonomy and Webb's DOK, Wiggins and McTighe (2007) have also developed the taxonomy of cognitive complexity in their Understanding by Design model. Wiggins and McTighe focus on cognitive complexity through a backward design perspective. When considering the Understanding by Design model (Wiggins and McTighe, 2007), the designer first considers the big idea of the unit of study and the transfer required (Stage 1). Then, the designer considers the assessments required to show understanding

(Stage 2) and finally, the learning activities (Stage 3) that focus directly on the transfer. The learning activities are leveled as acquisition, meaning-making, and transfer. This might include creating, designing, performing, self-assessing, etc. (Wiggins & McTighe, 2011).

Student Engagement

Engagement in the literature is typically described in one of three ways; behavioral, emotional, or psychological engagement (Archambault et al. 2009; Connell & Wellborn, 1991; Deci & Ryan, 1985; Finn, 1989; Fredricks et al. 2004; Fredricks, 2011; Patrick, Skinner, & Connell, 1993). There are compelling arguments that the three types of student engagement – emotional (allowing a wide band width of interpretation from anger to high interest), cognitive (more specific to problem solving) and behavioral (being on-task, paying attention, etc.) should form a “meta construct”; when one of the described engagement components (behavioral, emotional, and cognitive) are present, likely all are interactively present (Fredricks et al. 2004). One of the complexities in connecting engagement to achievement is that there are many engagement definitions – behavioral, emotional, cognitive, affiliative, etc. complicating connections to student achievement (Fredricks, 2011).

Dotterer and Lowe (2011) indicated classroom context and school engagement are significant in predicting academic achievement. Szucs (2014) also suggested that students’ perception of a positive school climate increases school engagement and student achievement. Szucs indicated that when a student gets consumed by the learning, the result is a greater chance of improved achievement.

Several researchers support the view that a student who is intrinsically motivated is engaged (Csikszentmihalyi, 1990; Deci & Ryan, 1985; Hidi & Renninger, 2006; Wang & Holcombe, 2010). The flow theory (Csikszentmihalyi, 1990) suggests that when a student is

totally immersed in a classroom activity that high level engagement results. Others support the theory that motivation, academic challenge, enjoyment, and achievement are increased when work is rigorous and delivered at high levels on Webb's DOK levels of complexity (Early, Rogge, & Deci, 2014; Schlechty, 1997; Wang & Eccles, 2013).

Csikszentmihalyi (1990) considered this high intensity level in his flow theory by describing real learning as occurring when a student is lost in the activity. He compared the flowing classroom environment to that of an athlete or musician totally consumed by the game or the tune and operating at the highest flow levels. He further conceptualized that while a student may not be a professional athlete, painter, dancer, etc., that flow is for each person totally engrossed in the learning activity. This flow is a natural and normal learning event engaging the student to feel the worth of the learning activity and to be totally consumed and engaged. Early et al. (2014) and Csikszentmihalyi (1990) indicate that the environment for optimal student engagement is in this flow. This level of student engagement, as measured in various ways (behaviorally, emotionally, or psychologically) has often been linked to academic success (Appleton et al. 2006; Finn & Rock, 1997; Klem & Connell, 2004).

Student engagement across grade levels.

Children begin school with a desire for learning and engagement. Marks (2000) suggested children enter school with three needs: "(1) the fundamental human need to develop and express confidence, (2) school membership, and (3) authentic academic work" (Marks, 2000, p. 158). Research indicates that the socioeconomic status, minority group membership, age of the student and other sociocultural factors impact classroom engagement (Bempechat & Shernoff, 2012; Lee & Smith, 1995; Steele, 1992).

Other factors affecting engagement.

There are differences in student engagement between low SES students and other minority/majority students (Bempechat & Shernoff, 2012; Steele, 1992). The consequences of classrooms characterized by low level rigor and student engagement for middle and high school students from disadvantaged backgrounds are especially severe (National Research Council and Institute of Medicine, 2004; Ogbu, 2003). Students from classrooms that are less rigorous and engaging are less likely to graduate and will face limited employment prospects, thereby increasing their risk of poverty, poor health, and involvement in the criminal justice system (Ogbu, 2003). For this reason, many educators, school psychologists, and community organizations are interested in obtaining better data on student engagement and disengagement for needs assessment, diagnosis, and prevention (Willms, 2003). For many low-income schools struggling to meet annual yearly progress, the combination of poverty and dispirited teachers is a powerful obstacle to overcome in any attempt to improve engagement (Bempechat & Shernoff, 2012; Eccles et al. 2006).

Minority group membership and student outcome data indicate the need to engage minority students academically, especially as it is measured through graduation rates (Finn & Cox, 1992; Sweat, Jones, Han & Wolfgram, 2013). In middle and high school however, there tends to be no difference between measured minority and non-minority student level of behavioral engagement (Lee & Smith, 1995). Minority elementary students are less engaged academically, but the trend tends to disappear at the middle and high school level (Ogbu, 2003; Steele, 1992).

Poverty plays a role in the gradual disenfranchisement from school (Ogbu, 2003). With 39% of students from a poverty background being over represented by African-American students, school disengagement creates an early beginning to societal stratification and ultimately

greater withdrawal from school and any nature of engagement with school (Bempechat & Shernoff, 2012; Ogbu, 2003).

Both Lee & Smith (1995) and Finn & Cox (1992) found cultural differences as well. There are significantly lower engagement levels in non-Hispanic white students at the secondary level (Lee & Smith, 1995).

The idea of differing levels of engagement is supported in findings indicating elementary school students reflect higher levels of motivation and engagement (Martin, 2009). At the early elementary level, a student's ability to follow directions or otherwise be behaviorally engaged can influence and be influenced by the student's cognitive development level (Mahatmya, Lohman, Matjasko, & Farb, 2012).

Engagement has been shown to decline as a student progresses through the upper elementary and middle school, reaching its lowest levels in high school (Marks 2000; National Research Council and Institute of Medicine, 2004). At the high school level, emotional engagement tends to dissipate in the same manner as behavioral and cognitive engagement (Eccles et al. 2006).

The maturational level of a student (childhood versus adolescence) plays a role in student engagement. Bronfenbrenner and Morris (1998) indicate the socialization process has a powerful effect on the level of student engagement, either psychological or behavioral. As the student matures and has more self-direction with complex work, there tends to be more satisfaction from the learning process and thus increases in the student being engaged in the learning process. When the work is not challenging or complex, there may be more disengagement (Bronfenbrenner, 1986a; Csikszentmihalyi & Larson, 1984; Csikszentmihalyi, 1990).

Piaget (as cited in McLeod, 2010) developed a theory of intellectual development that included four distinct stages: the sensorimotor stage, from birth to age 2; the preoperational stage, from age 2 to about age 7; the concrete operational stage, from age 7 to 11; and the formal operational stage, which begins in adolescence and continues into adulthood. Teachers who understand the developmental skills of the varying stages Piaget describes can maintain an appropriate expectation of complex thinking at all grade levels (Mahatmya et al. 2012).

As children develop through these cognitive stages, the role of parents and teachers changes; the locus of control around engagement and regulation becomes more the task of the student (Hughes, Luo, Kwok, & Loyd, 2008; Mahatmya et al. 2012). Mahatmya et al. (2012) further noted emotional engagement resulting from positive interactions gives the student a sense of belonging. Where persistent thoughtful consideration is given to the developmental needs of students, there is consistent engagement and achievement (Archambault, Pagani, & Fitzpatrick 2013).

There is engagement research specific to females. Girls overall tend to be more engaged regardless of the school level – elementary, middle or high school (Bempechat & Shernoff, 2012; Eccles et al. 2006; Lee & Smith, 1993, 1995). More academically successful middle and high school female students also report greater engagement (Lee & Smith, 1995).

Results of disengagement.

If some of the early issues of engagement are not addressed, students who lack school readiness or live in poverty circumstances will drop out (Archambault et al. 2009). For example, a male with academic or intellectual deficits, placed in special education, and with a pattern of low achievement is prone to being disengaged from school and likely to become a dropout (Archambault et al. 2009). Other considerations, such as school culture, curricular fragmentation,

weak instruction, and low expectations for student learning may affect engagement as well (Archambault et al. 2009; Bempechat & Shernoff, 2012). Disengagement intensifies when students are persistently in classrooms where there are poor student-teacher relations and low student engagement and achievement (Hughes et al. 2008). Where issues like climate, persistence and student involvement are not nurtured in the classroom, there is a progressive decline in engagement regardless of the grade level except in mathematics where there are similarities in engagement across all levels (Marks, 1995; Marks, 2000).

Disengagement can begin as early as kindergarten and in some cases can be mislabeled as a learning disability (Yazzie-Mintz, 2007). Disengagement leads to poor learning student outcomes (Alexander, Entwisle, & Kabbani, 2001; Finn & Cox, 1992).

The real problem of disengagement may simply be boredom and the consequential classroom disruption from this boredom (Yazzie-Mintz, 2010). The High School Survey of Student Engagement (HSSSE) report was designed to both help schools ascertain students' beliefs about their school experience and provide assistance to schools in translating data into action (Yazzie-Mintz, 2009). In the HSSSE report two out of three respondents (66%) in 2009 reported as being bored at least every day in class in high school; nearly half of the students (49%) were bored every day and approximately one out of every six students (17%) were bored in every class.

Csikszentmihalyi and Larson (1984) asked students to carry electronic pagers and self-report forms to monitor moods to judge boredom in the classroom. Students participating in this study were assigned beepers which were randomly activated resulting in students self-reporting on what they were doing in the classroom and their disposition relative to the class activity. Findings from the study reinforce the belief that student compliancy is considered more

important than engagement in schools. Csikszentmihalyi and Larson (1984) found that class time was associated with lower-than-average feeling of status on nearly every self-report dimension. Students reported moods of sadness, irritability, and boredom, all components of classroom disengagement.

Sedlak, Wheeler, Pullin, & Cusick (1986) and Steinberg (1996) reported that lack of engagement or inattention in class reportedly afflicts 40% to 60% of secondary school students, an estimate that excludes repeated absentees and dropouts. While elementary school students, especially the primary learner, do not show the same persistence around disengagement likely due to the developmental nature of the student (Marks, 2000 Tharp, 2012). The debate is persistent across educational levels regarding the utilitarian value of assigned work and the compliance of the student (Archambault, Pagano & Fitzpatrick, 2013; Archambault et al. 2009; Finn, 1993; Sedlak et al. 1986). The middle and high school student is developmentally capable of understanding the limited utilitarian value of meaningless learning activities (Finn, 1993; Goodlad, 1984; Sedlak et al. 1986).

Bempechat and Shernoff (2012) suggested a substantive relationship between underachievement and school disengagement. They characterized disengagement from a cyclic perspective and related gradual disengagement to the developmental cycle's characteristic of the movement through K-12 education (Tharp, 2012).

While student engagement is the primary objective of a teacher, however, there can be disengagement which Skinner et al. (2009) describes as disaffection. Disaffection is defined as "passivity, procrastination, giving up, boredom disinterest, and etc." (Skinner et al. 2009, p. 227).

Both disaffection and poor achievement are evident when children enter school (Willms, 2003). Willms suggests these risk factors are cumulative and predictive of longer-term life

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outcomes. The decline in student engagement can be even more dramatic as students move through feeder patterns of low-performing, high-poverty schools (Yazzie-Mintz 2009), especially if the student's performance skills are not addressed. It is estimated that by high school up to 50%, or in some instances, even a higher percent of youth are disengaged (Marks 2000). Estimates of the student disengagement at the middle and high school students range from 25 to 66 percent (Taylor &Parsons, 2011).

There are many school district efforts, especially at the secondary level (National Research Council and Institute of Medicine, 2004) to measure and improve student engagement to lower school dropout rates. Measuring student engagement in the classroom can identify students who may have become disengaged (Fredricks et al. 2004). Fredricks further indicates that a student begins the slow disengagement process early; this disengagement results in the high school decision when the student becomes of age to finalize the process.

In a Baltimore City Schools report of school disengagement and dropout findings indicated that by ninth grade a large majority of eventual dropouts are over age for their grade (Mac Iver, 2010). The study suggested that grade retention patterns may be contributing to the dropout problem and require analysis. Chronic absenteeism persisting over several years contributed to disengagement and subsequent school dropout. Mac Iver (2010) suggests that the study of the existing school retention and absentee patterns aligned with early interventions and other preventive measures should occur before the middle school years.

Engagement interventions.

The consequence of classrooms characterized by low level rigor and student engagement for middle and high school students from disadvantaged backgrounds are especially severe (National Research Council and Institute of Medicine, 2004; Ogbu, 2003). Students from

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classrooms that are less rigorous and engaging are less likely to graduate and will face limited employment prospects, thereby increasing their risk of poverty, poor health, and involvement in the criminal justice system (Ogbu, 2003). For this reason, many educators, school psychologists, and community organizations are interested in obtaining better data on student engagement and disengagement for needs assessment, diagnosis and prevention (Willms, 2003). As part of the increased focus on school accountability over the past 15 years, more attention has been paid to studying and reporting the effectiveness of interventions designed to improve student achievement outcomes (Skinner et al. 2009).

Engagement and disengagement are measures of the effective and ineffective K-12 setting (Cooper & Garner, 2012). There is a need to measure and monitor cognitive rigor and student engagement at all school levels but particularly at the high school level (National Governors Association Center for Best Practices and the Council of Chief State School Officers, 2009). The Institute for Research and Reform in Education (IRRE) initiative attempts to increase student engagement by stressing implementation of small learning communities and stronger relations with families (Connell et al. 2009).

Examples of interventions with engagement as a measure include the initiative of the Institute for Research and Reform in Education (IRRE). The IRRE implemented *First Things First*, a school reform model in which schools commit to improving engagement and strengthening relationships between students and adults (Connell et al. 2009). The IRRE initiative (January 2003) attempted to increase student engagement by stressing implementation of small learning communities and stronger relations with families. The IRRE initiated partnerships with schools, districts and states to transform public schools into more engaging rigorous and caring places for students to learn and teachers to teach. The focus was on

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secondary school with large numbers of economically disadvantaged students (Institute for Research and Reform in Education, January 2003). The Institute suggested five core strategies to improve academic results; strengthening instruction by effective use of data, personalized learning communities, advocating for students and families, and building system capacity to strengthen and sustain reform (Institute for Research and Reform in Education, January 2003).

Shernoff, (2002) in a speech to the California State Assembly Education Committee, shared his research findings connecting student learning to optimal engagement. His findings suggest 1) Students pay more attention and concentrate when they are challenged; 2) Student efficacy results from the ability to demonstrate their skills; 3) Students are sufficiently engaged when their skills match the level of the challenge; and 4) students are more engaged when the work is relevant and has some meaning to their lives.

When engagement across content areas at all levels of schooling was investigated, two major factors contributed to high student engagement in classrooms (Marks, 2000). The first factor was the inclusion or absence of authentic work. In classrooms where the work was authentic and required higher order thinking and higher order depth of knowledge and was connected to real-world experiences, students were more highly engaged in the learning environment (Blackburn, 2008; Buck, Carr & Robertson, 2008; Lent, 2012). Marks also noted that a positive environment in classrooms that were considered fair, respectful, and safe led to increased student engagement.

Lent (2012) suggested that engagement is an essential and necessary ingredient in the effective classroom while asserting that student engagement is reliant on students who feel connected to learning, what he refers to as “just-in-time learning” (p. 14). Lent compares it to adults who need or desire to know something for a purpose. Instilling curiosity for learning

develops intrinsic motivation and subsequent engagement in students (Deci & Ryan, 1985; Lent, 2012).

While Lent argued if learning is purposeful that students will be engaged, others suggest engagement is related to lesson rigor and the use of appropriate pedagogy in lesson delivery (Bowers & Powers, 2012; Ysseldyke, Spicuzza, Kosciolk, & Boys, 2003). Wagner (2008) asserted that student engagement is related to development of a quality lesson and the ability of the teacher to deliver such a lesson. This research supports the idea that students will be more actively engaged in work that is authentic, purposeful, and highly relevant (Buck et al. 2008; Schlechty, 2007).

Teachers asking insightful and challenging complex questions are rare, with classroom work generally at the DOK 1-2 level (The Standards Company, LLC, 2008a, 2008b). These results were supported by the New South Wales (NSW) Public Schools 2004 study indicating higher DOK levels are not the norm and were infrequently associated with cognitively complex instruction. The research did indicate that when school improvement initiatives focus on cognitively complex pedagogy, high quality and cognitively complex work results (Ladwig et al. 2007).

Psychological engagement.

Some educators may describe the emotion a student expresses by being psychologically engaged in classroom learning as being in the “flow”; the height of psychological engagement and often described as active learning (Csikszentmihalyi, 1990). Csikszentmihalyi, through his concept of flow, characterizes the psychological engagement of the student as being totally focused on the lesson and “in the moment” meaning they are engrossed and engaged

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emotionally, physically, and mentally with the lesson. Csikszentmihalyi would describe this type of engagement as essential to cognitive engagement and academic achievement.

Psychological involvement refers to the negative and positive affective responses that develop on the part of the student such as boredom or interest with classroom instruction, the sense of belonging to school, and the notion that school learning is valuable (Glanville & Wildhagen, 2007). While very often it is behavioral engagement that is tracked in school through indicators such as office referrals, it is psychological engagement that drives improvement in student outcomes and ultimately achievement (Pintrich & DeGroot, 1990; Wang & Eccles, 2007; Wang & Holcombe, 2012). Psychological engagement directly affects academic results and implies the student is working toward identified classroom learning outcomes (Connell, 1990; Dotterer & Lowe, 2011; Marks, 2000).

Motivation and psychological engagement seem closely related. Studies show that internal motivation is a powerful engagement tool (Deci & Ryan, 1985; Eggen & Kancheck, 2004). There may be as many reasons for a student to be compliant and engaged, especially psychologically engaged, as there are students. In the ideal classroom, students pay attention, ask questions and want to learn. Motivated students do their assignments without complaint and study without being coaxed and cajoled (Eggen, & Kancheck, 2004).

Teacher enthusiasm, imagination and lesson authenticity are factors leading to the psychological engagement of the student (Smith, Sheppard, Johnson & Johnson, 2005). Developing a lesson that appears to embody higher order thinking is not adequate. It is the pedagogy that inspires a student to want to engage in the learning tasks (National Research Council and the Institute of Medicine, 2004).

Motivated students perform. In the lesson set, a teacher sets up an expectancy that a benefit will occur as a result of their behavioral participation in the instructional experience (Skinner et al. 2009). The impact of motivation is the energizing aspect of directing and sustaining student engagement (Eggen & Kancheck, 2004). Motivation has the potential to impact and sustain psychological engagement over time (Krause, Bochner, & Duchesne, 2003).

While compliant (behavioral) engagement is essential for teaching and learning, psychological involvement is critical for the learner (Glanville & Wildhagen, 2007). Glanville and Wildhagen (2007) state:

“... Engagement is a general concept that includes many specific behaviours and attitudes” and it “... encompasses a range of behaviours and attitudes, with researchers and theorists applying different labels to these behaviours, such as participation, identification, attachment, motivation, and membership” (p. 1021).

Hughes and Zhang (2006) suggest other descriptors such as student interest and persistence. Engaging work allows a student to express his thinking either alone or with others in collaboration (Kenny, Blustein, Haase, Jackson & Perry, 2006). Janosz, Archambault, Morizot & Pagani (2008) suggest that the actual roots of student engagement could be parental involvement, family background, personal characteristics, and the larger school environment.

Student psychological engagement may only be obvious after sustained time in the classroom, and thus cannot be easily assessed. Some suggest lengthy and frequent data collection for analysis (Hess et al. 2009; Jones, 2014; Walkup, 2014).

Behavioral engagement.

It is impossible to know the level of psychological engagement in a typical classroom observation, but it is possible to observe students being attentive, compliant, and not interrupting

other students from engaging in the learning environment. Behavioral engagement can be thought of as student compliance within the limits of classroom expectations and refers to classroom and school participation such as following the rules, making an effort to learn, and the avoidance of behaviors that disrupt others, including the opportunity of the teacher to teach and a student to learn (Finn, 1989; Fredricks et al. 2004). Fredricks et al. (2004) suggest student involvement in learning tasks and participation in school related activities also indicate behavioral engagement.

The extent to which a student is behaviorally engaged may be due to parent expectations, reward and punishment in the school's disciplinary code, or persistence to avoid attention in the classroom (Janosz et al. 2008). While academic performance is influenced by many factors such as intelligence, achievement, etc., it is likely perseverance in learning and student effort have the greatest impact on learning (Carbonaro, 2005; Hughes et al. 2008). Hughes et al. (2008) indicate academic success simply begins with effort or a willingness to engage in the learning activity that sets the process of learning in motion. Compliant (behavioral) engagement is essential for teaching and learning to occur in the classroom and sets the learning process in motion (Glanville & Wildhagen, 2007).

Assessing behavioral engagement.

Tools for measuring student behavioral engagement vary. The typical method of measuring engagement is through instructional walkthroughs or rounds. These instruments are designed to briefly describe either teacher or student behavior using a checklist or anecdotal notes after a classroom observation. Examples of these walkthroughs are the Pittsburg Walkthrough and the Downey Walkthrough (Downey, Steffy, English, Frase, & Poston, 2004; Goldman et al. 2004). The goal of the walkthrough is to collect data that identify teacher

strengths and needs and ultimately inform the professional development for a school or even the district (Marsh et al. 2005).

The more commonly used engagement measure is a data collection system called the E-Walk or ELEOT - Effective Learning Environments Observation Tool (AdvanceED, 2012). This tool requires the observer spend at least 20 minutes in the classroom observing the teacher and students. These classroom observations produce findings that are typically not generalizable and yield unreliable data difficult to defend (Marzano, 2003).

Student behavioral engagement is measured in many forms. Some have used school attendance as a way to assess student engagement in the classroom. Hence, a student comes to school through the need to learn which may suggest there is a visceral relation between attendance and student engagement in the classroom (Yazzie-Mintz, 2010).

Fredricks et al. (2004) conducted a study to determine if there was a relationship between truancy and school engagement. School engagement was defined in three areas - behavioral, cognitive and emotional. This research indicated that truancy had an effect on school attendance only at the behavioral level. There was no significance at either the cognitive or emotional level; the implication is that school attendance data is not an effective tool to measure cognitively complex and psychologically engaging student work (Fredricks et al. 2004).

Lee (2014) suggests that classifying student engagement may take on three forms: 1) those who show up for class, do not disrupt, and whose behavior is not a distraction to the flow of the lesson – passive learners; 2) those who are involved in the flow of the lesson and actively contribute to the discussion of class work – active learners; and 3) those whose engagement is identified by the involvement and activity related to school clubs, organizations and any extra-curricular activity. Lee argued that persistence is the factor of most importance in judging

engagement; persistence indicates engagement when students ask questions, actively pursue a topic and do the assigned work.

Daeschner (2014) designed and implemented a walkthrough system to build teacher capacity about cognitive rigor and student engagement. His walkthrough process was created to build instructional capacity and consistency with instructional delivery by determining cognitive rigor using Webb's DOK (1997) and student engagement. Teachers accompanied administrators on instructional rounds to develop and share a common understanding of cognitive rigor and student engagement. They mutually used the results from the walkthroughs to inform school learning goals. It was the frequent use of brief walkthroughs that informed the teacher and administrative leaders' about classroom cognitive rigor, student engagement, and set improvement goals (Daeschner, 2014).

Inconsistency in using observational cognitive rigor measures is ineffective (Valli & Buese, 2007). They stressed the lack of a strategic plan to effectively use rigor data to improve the classroom learning climate may have negative results. The primary issue with using a walkthrough instrument assessing cognitive rigor is that administrators lack familiarity with measures of cognitive rigor and thus are unsure of its usefulness in teacher or school improvement (Supovitz & Weathers, 2004).

The instrument of choice should directly measure the intended outcome and use (Fredericks et al. 2011). The Student Engagement Rating Scale for the Classroom or SER-C is an instrument to capture student behavioral engagement and cognitive rigor complexity very quickly. The duration of a classroom walkthrough with this instrument is generally less than one and one-half minutes. Many brief observations are more useful than a few samples through more lengthy traditional observation means (Paige et al. 2013). This quick, web-based instrument is

meant to gather cognitive rigor and student engagement data that is valuable to teachers in the interpretation, reflection and growth of students (DuFour & Eaker, 2010).

Shewhart (1931) and later Deming (1982) suggest statistical data that is influenced by constant change (like the dynamics of a classroom) should not rely on limited classroom visitations to make generalizations. They compare the differences through two common sampling techniques - enumerative and analytical. Analytical sampling is the collection of data points from which interpretations are made. Deming and others characterize enumerative sampling as interpretation which may be made by calculation alone. In analytic sampling there is some sense of judgment, a need for knowledge of the subject, or even the discomfort of unknowns in data (Deming, 1982; Kerridge & Kerridge, 1998). The fundamental difference indicated in interpreting differences between enumerative and analytic data depends on whether the data samples are from fixed or dynamic sources (Deming, 1982; Provost, 2011). Beachell and Monda (1974, June) constructed a table which to describe typical examples of enumerative and analytic studies (See Table 2.4.)

Table 2.3.

Differences between Enumerative and Analytic Studies

ENUMERATIVE	ANALYTIC
Interest is in studying the group (material) from which data is retrieved	A prediction will be made about the process that produces the material.
Does not connect to future materials.	There is latitude as to whether change or not change the process that will produce the material in the future
The sample was chosen randomly from the	Special members were chosen for the sample

material	
The context of decisions are only on the material studied	The focus of the work will be on the process
Most statistical analyses are valid for inferences on the material under study	Statistical methods of inferences (DOE, t-tests, etc.) are not meaningful for prediction. If the conditions of the study are repeatable in the future, then statistical inference may be valid.
No decision will be made based on the process that generated the material studied	Document the statistical control of the variables

Note. Adapted from “A Primer for Enumerative Vs. Analytical Studies: Using caution in Statistical Inferences by E. Beachell and M. Monda, 1974, ASQC Statistics Division Newsletter 16 (3), p 8, Copyright 1974.

The use of analytic sampling from dynamic processes (systems that are changing versus systems fixed and constant) seems strategically more effective (Deming, 1982; Provost, 2011). This is the case for using the SER-C as a data collection tool. The SER-C instrument is intended to capture the changing dynamics of a classroom, reinforcing the idea that many observations are better than a few. Moreover, having observations spread across the class period and school day build support to using the instrument for reliable and valid analysis of cognitive rigor complexity and student engagement.

The SER-C walkthrough instrument may only be used by trained observers. The purpose of the training is to ensure a degree of consistency in the use of the instrument, including recognizing DOK levels, criteria to determine disengagement, and to determine teacher pedagogy. Regardless of the instrument, assessment developers stress the importance and necessity of observer training for consistency in observation results (Fredericks et al. 2011).

Summary

This research will examine the relationships among cognitive complexity as measured by Webb's depth of knowledge (DOK), student learning mode, and student behavioral engagement. Student engagement data at the classroom level will be collected by observing the behavioral engagement of students. The level of cognitive complexity (determined by Webb's DOK levels) will be assessed and used to analyze changes in student engagement data.

Chapter 3: Methods

The objective of this research is to evaluate the effect of cognitive rigor and learning mode on student engagement. The research questions guiding this study are:

1. What are the effects of depth of knowledge and learning mode on student engagement?
2. Are there interaction effects among depth of knowledge and learning mode and what impact does the interaction have on student engagement?
3. Do the effects of LM and DOK on engagement vary by educational level?

While behavioral, emotional, and psychological engagement is identified in the literature, this study assesses only student behavioral engagement. (Fredricks et al. 2011; Skinner et al. 2009; Marks, 2000; Miserandino, 1996; Connell & Wellborn, 1994; Patrick et al. 1993; Finn, 1989; Deci & Ryan, 1985),

Study Context

The research study was conducted in a small, rural, four-school district in northern Kentucky. Key criteria in choosing this district were first, the total district enrollment numbers were at a manageable level allowing for an assessment across all district schools. Secondly, district and building-level leadership were very willing to engage in the training and data-gathering process necessary to inform the state of cognitive rigor and student engagement across the district.

The district under study consists of two schools enrolling students at the elementary level, one at the middle-grades level and a fourth school at the high school level. Of the two elementary schools, one enrolled students in grades kindergarten through second, while the second enrolled students in grades 3 to 5. The middle school consisted of grades 6 through 8, while the high school was the traditional grade configuration of grade 9 to 12. The division of the elementary

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schools created no particular problem in that data were combined from both elementary schools into one elementary data base for the purpose of interpreting results at the elementary, middle, and secondary grade levels.

District Description

Of the 1,590 students attending the four schools comprising the study district, 391 students were enrolled in the lower-elementary school (K-2) grades, 390 were enrolled in the upper-elementary school (3-5), 367 students attended the middle school (6-8), and 442 students were enrolled in the high school (9-12). Sixty-nine percent of the students enrolled in the four district schools received free (64%) or reduced-price lunch (5%). The distribution of student ethnicity across the district consisted of approximately 89% who self-identified as white, less than 1% self-identified as African American, 9% self-identified as Hispanic, and less than 1% self-identified as other. Each of the four school principals had more than five (5) years' experience as administrators.

Unit of Measurement

To collect the measured variables, observations were taken at the classroom level. The observation protocol called for the observer to enter the classroom unannounced for approximately 1 to 2 minutes, during which time the measures of student engagement, depth-of-knowledge, and learning mode were recorded as an average for the class. As such, the unit of measure is the classroom.

Study Variables

This study is concerned with the measurement of three variables. The independent (outcome) variable is student behavioral engagement while the two dependent variables are depth of knowledge (DOK) and learning mode (LM).

Behavioral engagement.

Student behavioral engagement is defined as the percent of students present in a classroom who appear to be physically attending to instruction at the time of the observation (Cooper & Garner, 2012; Lent, 2012; Glanville & Wildhagen, 2007; Fredricks et al. 2004). The primary student indicator suggesting behavioral engagement is the assumption of a physical position directed toward the focus of instruction, whether that focus is the teacher, a fellow student, a small or cooperative group activity, or independent work. Conversely, contra-indicators of physical engagement can be observed which suggest the student is not engaged with the instruction at hand. These indicators include positioning the head on the desk in a resting position within crossed arms, engagement in a non-instructional conversation with another student, and the focusing of physical attention to a phenomenon not associated with instruction.

To calculate the percentage of students exhibiting behavioral engagement for any classroom observation, the number of engaged students is divided by the total number of students in the classroom. For example, if in a classroom of 24 students, 21 were determined to exhibit behavioral engagement, the resulting percentage of students engaged with instruction would be 21 divided by 24 which equal 87.5% or 88%. A pilot study revealed that teachers had difficulty calculating the mathematical percentage of students exhibiting behavioral engagement with instruction. To eliminate the need for calculations, teachers simply entered the total number of students present in the classroom and the number not behaviorally engaged. The digital device then performed the calculation to arrive at the percentage of students behaviorally engaged.

Depth of knowledge.

Depth-of-knowledge (DOK) is measured as an ordinal variable using Webb's (1997) DOK scale. Webb's DOK enables the recording of what authors refer to as knowledge work

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(Blackler, 1995; Drucker, 2001; Schlechty, 2002; Zuboff, 1988). Within Webb's DOK, a rating of 1 indicates an activity requiring the recall of knowledge. An example of recall would be the memorization of math facts. The DOK of a 2 indicates knowledge work that requires the learner to apply previously learned knowledge, such as applying knowledge of math facts to solve a mathematical problem. In Webb's DOK, a rating of a 3 is used when knowledge work involves the synthesis of thinking to solve problems. For example, the solution to a problem may require the consideration of knowledge on a variety of topics, each of which must be factored, or synthesized, into a final solution. Finally, a rating of 4 indicates thinking that is engaged in an original creative activity, examples of which include original writing, creation of a painting or other work of art, or an improvement upon a process.

To arrive at a DOK level for a classroom, the observer directs attention not to the teacher, but to the knowledge work engaged in by the students. A determination is then made of the DOK level required by the student to complete the knowledge work. As such, the observer rates the knowledge work as a 1, 2, 3, or 4. In a class setting where students have been grouped into subgroups and are working on different knowledge work assignments, the observer records the DOK level representing the work engaged in by the largest number of students.

Learning mode.

Learning mode is recorded as a dichotomous variable indicating whether students are working alone or with others, and is most often identified in the research as active and passive learning (Chi, 2009). While working with others is collaborative in nature, active learning is best characterized by a group of students involved on an interactive basis with each other. Working with others and interactive learning involves an action component implying psychological engagement and potentially, increases in behavioral student engagement (Fredricks et al. 2004;

Csikszentmihalyi, 1990). Learning mode is recorded by the observer as reflecting the entire class. Again, for a class that has been divided into two or more activities, the observer records the learning mode reflecting the greatest number of students.

Data Collection

Observations were gathered from January to January across two school years. Data was collected by administrators and teachers trained in the observation of the variables under study. A total of 86 teachers were involved in classroom observations and data collection across the district. By school building, this results in 20 teachers each from the lower- and upper-elementary schools, 20 from the middle school, and 28 teachers from the high school for a total of 88 classrooms across the district.

Data collection instrument.

To facilitate the collection of classroom observations, a digital application was programmed that allowed observers to enter data into a web-based tool, eliminating the need for paper and potential for transcription errors. Collected as part of each classroom observation was the grade-level of the observed classroom, the observed depth of knowledge (DOK) required by the knowledge work which students were engaged in, and whether students were working alone or with others.

Data sampling.

To determine a sufficient sample size necessary to detect significance in the measured variables, an a priori power analysis was conducted using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009). G*Power estimation parameters were set for an *F*-test (ANOVA fixed effects, special, main effects, and interactions) with an effect size equal to 0.1, alpha level to 0.05, power (1- β error probability) set to 0.8, numerator *df* = 3, and number of groups (elementary, middle,

and high school) equal to 3. The a priori estimation resulted in a total observation size equal to 1,095.

To determine the number of observations per classroom, the number of observations resulting from the a priori estimation (1,095) was divided by the total number of classrooms across the four buildings (88). This resulted in a minimum sample of 12.4 observations per classroom.

A total of 2,382 classroom observations were obtained for this study. Table 3.1 shows the sampling plan by school and the number of observations required for each school.

Table 3.1.

Minimum Number of Observations and Number Obtained by School

	Lower School	Upper School	Middle School	High School
Number of classroom units	20	20	20	28
Minimum number of walkthroughs needed	160	160	160	224
Number of walkthroughs obtained	405	671	742	564

The minimum quantity of observations reflects the number that would provide sufficient statistical power to detect potential effects in the measured variables. The data gathering plan was constructed to ensure that a representative number of observations would be collected across all class periods (55 minutes each) and days of the week (Monday through Friday). Observations were unannounced to classroom teachers. Of the 2,382 observations collected for this study, 2,120 (89%) were collected by administrators, 253 (10.6%) were collected by four teachers

trained to use the observation instrument, and less than 1% were collected by others. The administrative group represented both school specific administrators and central office administrators.

Classroom observation protocol.

To record the variables of interest, the observer entered the classroom and observed the students. Because of the observer's entrance into the classroom and to compensate for the potential distraction of students the observer allowed less than 1 minute for students to refocus on their previous task. While students were refocusing, the observation began by counting the number of students present. Once students were refocused, a count is made of those not behaviorally engaged with instruction. Next, students were observed as they were engaged in learning. The observer determined from watching the students the DOK level required of the learning. If the observer was unsure as to the nature of the knowledge work, a student or two were queried as to what they are doing. The DOK level was then recorded as a 0, 1, 2, 3, or 4, with 0 representing no learning occurring, 1 representing recall, 2 representing basic application of a skill or concept, 3 representing strategic thinking, and 4 representing creating or extended thinking. Next, the observer recorded whether students were working alone (independently) or together (in pairs or groups). The final determination of DOK was made based on what the majority of students were doing.

Observer training.

Before data collection began, approximately 12 district personnel (teachers and administrators) were trained to collect observations using the web-based instrument. Training consisted of first, an introduction to the instrument and secondly, the constructs of Webb's DOK scale. Recording Webb's DOK scale consisted of distinguishing between the four DOK levels

and the types of instructional activities associated with them. Observers were then taught to identify students exhibiting behavioral disengagement from instruction. For example, students with their heads down, engaged in inappropriate conversations, or otherwise not attending to instruction would be identified as disengaged.

This initial training was followed by two, 1-hour sessions with 8-12 paired observations in actual classrooms. After each observation, the researcher and teacher-trainee would enter the data on their web device in a condition blind to the other, after which ratings for engagement and rigor would be compared. Training continued until there was consistency in determining the DOK level and within one student on the number disengaged. Those gathering data are categorized as administrators, non-district personnel, teachers, or others.

Following the initial training, the process was designed to generate additional observers using a “train-the-trainer” model. Consistency among data collectors was monitored through periodic meetings, as well as auditing the data to assess the presence of data points considered as outliers. Critical areas monitored during observations were teacher pedagogy, coding DOK and learning mode, and calculating student engagement percentage. Once the school-based teams began the observation process, data was monitored regularly. When observations appeared to contain outlier values, inquiry was made and when necessary, the district trainer retrained observers to insure observation protocols were being followed.

Chapter 4: Results

This research study was designed to answer three questions: (a) what are the effects of depth of knowledge and learning mode on student engagement?; (b) are there interaction effects between depth of knowledge and learning mode and what impact does the interaction have on

student engagement?; and, (c) how do the effects of Depth of Knowledge (DOK) and learning mode (LM) on student engagement vary by educational level (elementary, middle and high school)?

Research Question One Results

A two by four main effects ANOVA was used to investigate research question one: “what are the effects of depth of knowledge and learning mode on student engagement?” The descriptive statistics table (See Table 4.1 and Table 4.2) gives an indication of the observed differences in student engagement between levels of DOK and LM.

Table 4.1.

DOK Descriptive Statistics

Dependent Variable: Engagement

DOK	N	Mean	Median	SD	SE	95% CI
Recall	865	88.92	95.00	19.87	.51	[87.03, 89.92]
Application	1042	93.21	96.50	10.95	.46	[92.30, 94.11]
Strategic thinking	378	95.35	100.00	8.82	.76	[93.86, 96.85]
Creating	97	91.45	100.00	12.00	1.51	[88.50, 94.40]
Total	2382	92.08	96.00	14.80	.31	[91.48, 92.67]

Table 4.2.

LM Descriptive Statistics

Dependent Variable: Engagement

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LM	N	Mean	Median	SD	SE	95% CI
LM -1	1044	90.97	95.00	18.25	.62	[89.76, 92.18]
LM -2	1338	93.49	100.00	11.32	.50	[92.51, 94.47]
Total	2382	92.08	96.00	14.80	.31	[91.48, 92.67]

The results of the ANOVA indicated both DOK, $F(3, 2379) = 19.663, p < .001, \eta^2_{\text{part}} = .024$ and LM, $F(1, 2381) = 15.230, p < .001, \eta^2_{\text{part}} = .006$ have a significant effect on student engagement.

Table 4.3.

Tests of Between-Subjects Effects

Dependent Variable: Engagement

Source	Type III SS	df	MS	F	<i>p</i>	η^2_{part}
Corrected Model	22305.23 ^a	4	5576.318	26.19	.00	.04
Intercept	8598768.12	1	8598768.12	40393.09	.00	.94
DOK	12557.47	3	4185.82	19.66	.00	.02
LM	3242.15	1	3242.15	15.23	.00	.01
Error	506009.17	2377	212.88			
Total	20722696.00	2382				
Corrected Total	528314.40	2381				

a. R Squared = .042 (Adjusted R Squared = .041)

b. Computed using alpha = .05

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Adjusted, post-hoc pairwise comparisons were used to compare the observed student engagement for the DOK levels. Significant differences in student engagement levels were identified between recall (M= 88.92) and application (M= 93.21) ($p < .001$) and recall and strategic thinking (M= 95.3) ($p < .001$) DOK levels. The observed level of student engagement associated with the recall level of DOK is significantly lower than observed engagement associated with application and strategic thinking levels of DOK.

Adjusted, post-hoc pairwise comparisons were also used to compare observed student engagement for the two levels of learning mode. The results in Table 4.2 reveal observed student engagement is significantly higher (M= 93.49) when students are working with others than the observed engagement when students are working alone (M= 90.97).

Table 4.4.

Pairwise Comparisons - DOK

Dependent Variable: Engagement

(I) DOK	(J) DOK	Mean Difference (I-J)	SE	Sig. ^b	95% CI ^b
	Application	-4.285*	.704	.000	[-6.142, -2.427]
Recall	Strategic Thinking	-6.432*	.933	.000	[-8.896, -3.967]
	Creating	-2.526	1.606	.695	[-6.765, 1.714]
Application	Recall	4.285*	.704	.000	[2.427, 6.142]

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	Strategic				
	Thinking	-2.147	.877	.086	[-4.462, .168]
	Creating	1.759	1.557	1.000	[-2.352, 5.870]
Strategic	Recall	6.432*	.933	.000	[3.967, 8.890]
Thinking	Application	2.147	.877	.086	[-.168, 4.462]
	Creating	3.906	1.665	.114	[-.490, 8.303]
	Recall	2.526	1.606	.695	[-1.714, 6.765]
Creating	Application	-1.759	1.557	1.000	[-5.870, 2.352]
	Strategic				
	Thinking	-3.906	1.665	.114	[-8.303, .490]

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

^b. Adjustment for multiple comparisons: Bonferroni.

Table 4.5.

Pairwise Comparisons – LM

Dependent Variable: Engagement

(I) LM	(J) LM	Mean Difference (I-J)	SE	Sig. ^b	95% CI ^b
Alone	With Others	-2.521*	.646	.000	[-3.787, -1.254]
With Others	Alone	2.521*	.646	.000	[1.254, 3.787]

Based on estimated marginal means

- *. The mean difference is significant at the .05 level.
- b. Adjustment for multiple comparisons: Bonferroni.

Summary for research question one.

In the main effects model, the overall model effect is significant ($p < .001$) however the variability in observed engagement explained by the model is limited ($R^2 = .04$). Both of the main effects (DOK and LM) have a significant impact on student engagement but the effect sizes are small ($\eta^2_{part} < .05$). Pairwise comparisons of the levels of DOK indicate observed engagement is significantly higher for the applications and critical thinking levels when compared to the recall level. Pairwise comparison of learning mode levels reveal engagement is significantly higher when students are working in groups rather than alone

Research Question Two Results

The second research question addresses the interaction effects between depth of knowledge and learning mode and what impact the interaction of DOK and LM have on student engagement. In addressing the question a full factorial two (2) by four (4) model with two way interaction was used to determine the interaction effect of DOK and learning continuum to the model.

Table 4.6.

Descriptive statistics

Learning Mode									
Working alone					With others				
DOK	N	M	SD	95%	N	M	SD	95%	
1	576	86.82	22.39	[85.627, 88.008]	289	91.87	12.93	[90.185, 93.545]	

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2	353	92.80	10.72	[91.281, 94.322]	689	94.03	11.06	[92.941, 95.117]
3	106	95.27	7.99	[92.499, 98.048]	272	96.15	9.13	[94.422, 97.886]
4	9	96.78	4.29	[87.256, 106.300]	88	92.03	12.45	[88.989, 95.079]

The overall factorial model effect is significant ($p < .001$, Table 4.7) but similar to the main effects model associated with the previous question the amount of variability the model explains is very small ($R^2 = .05$). The effect of DOK is significant $F(3, 2379) = 18.211, p < .001, \eta^2_{\text{part}} = .022$. The main effect of learning mode is no longer significant $F(1, 2381) = .189, p < .664$ however the interaction effect of DOK*Learning mode is significant $F(3,2379)=3.542, p < .014, \eta^2_{\text{part}} = .004$

Table 4.7.

Tests of Between-Subjects Effects

Dependent Variable: EngagPercen

Source	Type III SS	df	MS	F	p	η^2_{part}	Observed Power ^b
Corrected Model	24560.229 ^a	7	3508.604	16.535	.000	.046	1.000
Intercept	3833765.760	1	3833765.760	18067.066	.000	.884	1.000
DOK	11592.845	3	3864.282	18.211	.000	.022	1.000
LM	40.098	1	40.098	.189	.664	.000	.072
DOK * LM	2254.898	3	751.666	3.542	.014	.004	.788
Error	503754.159	2374	212.196				
Total	20722696.000	2382					
Corrected Total	528314.398	2381					

a. R Squared = .046 (Adjusted R Squared = .044)

b. Computed using alpha = .05

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To identify the simple effects associated with the significant DOK*learning mode interaction, adjusted post-hoc pairwise comparisons were used. Table 4.8 is a summary of the pairwise results.

Table 4.8.

Pairwise comparisons for DOK and LM interactions

Dependent Variable: EngagPercen

LM	(I) DOK	(J) DOK	Mean Difference (I-J)	Std. Error	Sig. ^b
Alone	Recall	Application	-5.984*	.985	.000
		Strategic Thinking	-8.456*	1.540	.000
		Creating	-9.960	4.793	.252
	Application	Recall	5.984*	.985	.000
		Strategic Thinking	-2.472	1.613	.754
		Creating	-3.976	4.817	1.000
	Strategic Thinking	Recall	8.456*	1.540	.000
		Application	2.472	1.613	.754
		Creating	-1.504	5.058	1.000
	Creating	Recall	9.960	4.793	.252
		Application	3.976	4.817	1.000
		Strategic Thinking	1.504	5.058	1.000
With Others	Recall	Application	-2.164	1.021	.205
		Strategic Thinking	-4.289*	1.231	.003
		Creating	-.169	1.774	1.000
	Application	Recall	2.164	1.021	.205
		Strategic Thinking	-2.125	1.043	.250
		Creating	1.995	1.649	1.000
	Strategic Thinking	Recall	4.289*	1.231	.003
		Application	2.125	1.043	.250
		Creating	4.110	1.786	.127
	Creating	Recall	.169	1.774	1.000
		Application	-1.995	1.649	1.000
		Strategic Thinking	-4.110	1.786	.127

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The simple effects associated with the interaction are limited to differences in student engagement at the recall, application and strategic thinking levels of DOK. When working alone student engagement differences replicate the main effects. That is engagement is significantly higher at the application (M= 92.80) and strategic thinking (M= 95.27) levels of DOK than it is at the recall level (M= 86.82). When working with others, the effect of DOK on engagement changes. Specifically the effect of DOK on engagement when working in groups is limited to higher engagement at the strategic thinking level (M= 96.15) when compared to recall (M 91.87). When working in groups, the differences in engagement between DOK application and DOK recall observed in the main effects model as well as among classes when working alone is not significant.

Summary for research question two.

The full factorial model featuring the main effects of DOK and learning mode as well as the DOK*learning mode interaction on observed student engagement was statistically significant but explained less than 5% of the total variability in student engagement. The effect of DOK was significant with a small effect size ($\eta^2_{\text{part}}=.022$) but the effect of learning mode was not significant ($p = .664$). The interaction effect of DOK*learning mode was significant with a very small effect size ($\eta^2_{\text{part}}=.004$) and the corresponding simple effects were limited to differences between engagement rates at the recall and application levels of DOK based on learning mode.

Research Question Three Results

Research question three investigates the effects of DOK and learning mode on student engagement when educational level is considered. The research question is: how do the effects of Depth of Knowledge (DOK) and learning mode (LM) on student engagement vary by educational level (elementary, middle and high school)?

In addressing this question the data were split by building level (elementary, middle and high school) and a full factorial two (2) by four (4) model with two way interaction was used to investigate the effects of DOK and learning mode at each educational level.

Elementary results.

The descriptive statistics table (See Table 4.9.) gives an indication of the observed differences in student engagement DOK and LM at the elementary level. The dependency of both learning mode and the interaction effects of DOK*LM are revealed with only DOK being significant at this level. See Table 4.10.

Table 4.9.

Descriptive statistics – Elementary School Level

		Learning Mode							
		Working alone				With others			
DOK	N	M	SD	95%	N	M	SD	95%	
1	245	88.73	18.99	[87.201, 90.260]	206	92.29	9.60	[90.623, 93.959]	
2	116	92.87	9.09	[90.648, 95.093]	414	94.47	9.85	[93.297, 95.650]	
3	2	79.00	24.04	[62.072, 95.928]	76	97.29	4.80	[94.543, 100.036]	
4	1	100.00	0.00	[76.060, 123.940]	16	98.44	3.54	[88.989, 95.079]	

In addressing the effects for question three at the elementary level, the model results indicated the following: DOK is significant $F(3, 1072) = 5.180; p < .05, \eta^2_{part}=.014$, the effects of learning mode and the interaction of DOK* learning mode are not significant. Adjusted pairwise comparisons of DOK levels indicate student engagement is lower at recall levels (M= 90.36) than it is at application (M= 94.12) and strategic thinking (M= 96.82).

Table 4.10.

Tests of Between-Subjects Effects - Interaction Effects

Dependent Variable: EngagPercen

SchLevel	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Elementary	Corrected Model	7743.361 ^a	7	1106.194	7.431	.000	.046
	Intercept	346062.147	1	346062.147	2324.735	.000	.685
	DOK	2312.992	3	770.997	5.180	.001	.014
	LM	300.313	1	300.313	2.017	.156	.002
	DOK * LM	680.053	3	226.684	1.523	.207	.004
	Error	158976.582	1068	148.854			
	Total	9434953.000	1076				
	Corrected Total	166719.943	1075				

Middle school results.

The descriptive statistics table (See Table 4.11.) gives an indication of the observed differences in student engagement DOK and LM at the middle school level. The dependency of both learning mode and the interaction effects of DOK*LM are revealed with only DOK being significant at this level. See Table 4.11.

Table 4.11.

Descriptive statistics – Middle School Level

Learning Mode									
Working alone					With others				
DOK	N	M	SD	95%	N	M	SD	95%	
1	266	86.62	21.61	[86.865, 90.376]	42	91.17	20.32	[86.749, 95.585]	
2	182	95.39	7.05	[93.268, 97.512]	95	95.79	6.24	[92.852, 98.727]	

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3	85	97.72	4.09	[94.012, 100.223]	50	97.72	3.88	[93.671, 101.769]
4	5	98.20	2.49	[85.395, 111.005]	17	95.76	5.98	[88.820, 102.709]

At the middle school level, like the elementary level DOK is significant $F(3, 738) = 7.120, p < .05, \eta^2_{part} = .028$. The effects of learning mode as well as the interaction of DOK*learning mode were not significant. Adjusted pairwise comparisons of DOK levels indicate student engagement is lower at recall levels ($M = 88.97$) than it is at application ($M = 95.53$) and strategic thinking ($M = 97.34$).

Table 4.12.

Tests of Between-Subjects Effects - Interaction Effects

Dependent Variable: EngagPercen

SchLevel	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
	Corrected Model	9824.203 ^c	7	1403.459	6.598	.000	.059
	Intercept	1727369.318	1	1727369.318	8120.917	.000	.917
	DOK	4543.242	3	1514.414	7.120	.000	.028
Middle	LM	3.706	1	3.706	.017	.895	.000
	DOK * LM	159.443	3	53.148	.250	.861	.001
	Error	156126.338	734	212.706			
	Total	6605289.000	742				
	Corrected Total	165950.551	741				

High school results.

The descriptive statistics table (See Table 4.11.) gives an indication of the observed differences in student engagement DOK and LM at the middle school level. The dependency of both learning mode and the interaction effects of DOK*LM are revealed with only DOK being significant at this level. See Table 4.13.

Table 4.13

Descriptive statistics – High School Level

Learning Mode									
Working alone					With others				
DOK	N	M	SD	95%	N	M	SD	95%	
1	65	72.23	30.81	[68.060, 76.402]	41	90.44	17.46	[85.187, 95.691]	
2	55	84.09	17.50	[79.556, 88.626]	180	92.08	14.82	[89.571, 94.584]	
3	19	88.74	13.11	[81.022, 96.452]	146	95.02	11.66	[92.244, 97.811]	
4	3	93.33	5.77	[93.917, 112.849]	55	89.02	14.49	[84.484, 93.553]	

At the high school level the main effects of DOK $F(3,560) = 5.943, p = .001, \eta^2_{part}=.031$, learning mode $F(1,562) = 5.705, p < .017, \eta^2_{part}=.010$ and the interaction effect of DOK*LM $F(3,560) = 3.042, p < .029, \eta^2_{part}=.016$ are significant (See Table 4.14): Adjusted pairwise comparisons examining the simple effects associated with the interaction of DOK*learning mode indicate that when working alone student engagement is significantly lower when the DOK level is recall than when the DOK level is application or strategic thinking.

Table 4.14.

Tests of Between-Subjects Effects - Interaction Effects

Dependent Variable: EngagPercen							
SchLevel	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
HS	Corrected Model	26719.933 ^d	7	3817.133	13.022	.000	.141
	Intercept	1047316.761	1	1047316.761	3572.918	.000	.865
	DOK	5226.576	3	1742.192	5.943	.001	.031

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LM	1672.423	1	1672.423	5.705	.017	.010
DOK * LM	2675.033	3	891.678	3.042	.029	.016
Error	162978.316	556	293.126			
Total	4682454.000	564				
Corrected Total	189698.248	563				

a. R Squared = .046 (Adjusted R Squared = .040)

b. Computed using alpha = .05

c. R Squared = .059 (Adjusted R Squared = .050)

d. R Squared = .141 (Adjusted R Squared = .130)

Table 4.15.

Pairwise Comparisons for DOK Interaction Effects

Dependent Variable: Engagement							
SchLevel	(I) DOK	(J) DOK	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
						Lower Bound	Upper Bound
Elementary	Recall	Application	-2.853*	.830	.004	-5.046	-.660
		Strategic Thinking	-5.007*	1.561	.008	-9.133	-.882
		Creating	-6.810	3.045	.153	-14.757	1.238
	Application	Recall	2.853*	.830	.004	.660	5.046
		Strategic Thinking	-2.154	1.490	.891	-6.092	1.784
		Creating	-3.957	3.011	1.000	-11.916	4.003
	Strategic Thinking	Recall	5.007*	1.561	.008	.882	9.133
		Application	2.154	1.490	.891	-1.784	6.092
		Creating	-1.802	3.268	1.000	-10.441	6.836
	Creating	Recall	6.810	3.045	.153	-1.238	14.757
		Application	3.957	3.011	1.000	-4.003	11.916
		Strategic Thinking	1.802	3.268	1.000	-6.836	10.441
Middle	Recall	Application	-6.364*	1.234	.000	-9.627	-3.101
		Strategic Thinking	-8.152*	1.532	.000	-12.204	-4.90
		Creating	-6.748	3.312	.252	-15.509	2.013
	Application	Recall	6.364*	1.234	.000	3.101	9.627
		Strategic Thinking	-1.788	1.529	1.000	-5.832	2.257
		Creating	-.384	3.271	1.000	-9.036	8.268

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Strategic Thinking	Recall	8.152*	1.532	.000	4.90	12.204
	Application	1.788	1.529	1.000	-2.257	5.832
	Creating	1.403	3.386	1.000	-7.554	10.361
Creating	Recall	6.748	3.312	.252	-2.013	15.509
	Application	.384	3.271	1.000	-8.268	9.036
	Strategic Thinking	-1.403	3.386	1.000	-10.361	7.554

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4.16.

*Pairwise Comparisons for the Simple effects of the Interaction of LM*DOK*

Dependent Variable: EngagPercen								
SchLevel	LM	(I) DOK	(J) DOK	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
							Lower Bound	Upper Bound
HS	Alone	Recall	Application	-11.860*	3.137	.001	-20.165	-3.555
			Strategic Thinking	-16.506*	4.465	.001	-28.329	-4.684
			Creating	-21.103	10.110	.224	-47.872	5.667
		Application	Recall	11.860*	3.137	.001	3.555	20.165
			Strategic Thinking	-4.646	4.556	1.000	-16.709	7.417
			Creating	-9.242	10.151	1.000	-36.119	17.634
		Strategic Thinking	Recall	16.506*	4.465	.001	4.684	28.329
			Application	4.646	4.556	1.000	-7.417	16.709
			Creating	-4.596	10.637	1.000	-32.759	23.566
	Creating	Recall	21.103	10.110	.224	-5.667	47.872	
		Application	9.242	10.151	1.000	-17.634	36.119	
		Strategic Thinking	4.596	10.637	1.000	-23.566	32.759	
	With Others	Recall	Application	-1.639	2.963	1.000	-9.483	6.206
			Strategic Thinking	-4.588	3.026	.780	-12.601	3.424

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	Creating	1.421	3.533	1.000	-7.932	10.774
	Recall	1.639	2.963	1.000	-6.206	9.483
Application	Strategic Thinking	-2.950	1.907	.735	-7.999	2.099
	Creating	3.060	2.638	1.000	-3.925	10.044
	Recall	4.588	3.026	.780	-3.424	12.601
Strategic Thinking	Application	2.950	1.907	.735	-2.099	7.999
	Creating	6.009	2.709	.162	-1.163	13.181
	Recall	-1.421	3.533	1.000	-10.774	7.932
Creating	Application	-3.060	2.638	1.000	-10.044	3.925
	Strategic Thinking	-6.009	2.709	.162	-13.181	1.163

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Summary for research question three.

There were several key findings resulting from the data that answers the research questions are the following:

- 1.) In the full factorial model DOK is significant at all three levels ($p \leq .05$).
- 2.) LM is not significant at the elementary level with $p \geq .156$ or the middle level with $p \geq .895$ and is significant at the high school level with $p \leq .017$
- 3.) The interaction of DOK*LM is not significant at the elementary level ($p \geq .156$) and the middle school level ($p \geq .861$).
- 4.) The interaction of DOK*LM is significant with $p \leq .029$ at the high school level
- 5.) The simple effects associated with the interaction effect of DOK*learning mode in high school are significantly greater engagement when students are working alone at the application or strategic levels of DOK when compared to engagement when working alone at the recall level. These differences in engagement at the different levels of DOK are not evident when students are working in groups.

Chapter 5: Discussion

Student motivation remains a key to engagement educators have known for years and that students rise to teacher expectations of a classroom environment that is dynamic, compelling, active and engaging (Bempechat & Shernoff, 2012; Schlechty, 1997; Deci & Ryan 1985).

Student disengagement with classroom instruction becomes evident through lagging academic achievement, boredom with the expected learning, and giving up and dropping out before graduation (Yazzie-Mintz, 2011). This classroom reality continues to plague many of our schools, prompting school leaders to focus on potential solutions for improving student engagement (Bempechat & Shernoff, 2012).

This research measured the relationship among three variables; student classroom engagement with instruction, the cognitive complexity of the learning (Webb, 1997, 1999), and learning mode (working alone or with others). The data results analyzed the extent to which cognitive complexity and learning mode effected student engagement.

Discussion of Research Question One

The first research question was, “What are the effects of depth of knowledge and learning mode on student engagement?” The results of this study support the hypothesis that an increase in cognitive complexity results in an increase in student engagement. The mean engagement percentage across the 2,382 classroom observations representing all grade levels across the district was 92%. This overall engagement data indicate that out of a class of 25 students, 8% or 2 students are disengaged at any moment. As the teacher increases the cognitive complexity of the thinking level through DOK 3, student engagement increases from 89% at the DOK 1 level to 95% at the DOK 3 level. The data indicates that at the DOK 4 level there is no significant difference in student engagement between DOK 4 and DOK 1. Pairwise comparisons indicate there are only significant differences between recall and application and recall and strategic thinking.

Implications for educators.

Implications for educators from the main effects of DOK and LM indicate that both are significant in increasing student rigor. The key finding other than that both DOK and LM impact student engagement is that at the DOK 4 level student engagement decreases. The mean engagement value at DOK 1 is 88.9%; whereas the mean engagement value at the DOK 4 level is 91.4% with there being no significant difference in student engagement at the DOK 1 or DOK 4 level. As teachers consider the pedagogy which has the greatest impact on student engagement and students are working at the DOK 4 level, the greatest impact on student engagement occurs when students are working alone. The key finding appears to nudge the teacher to use their teaching strategies to determine whether students should be working alone or working with others at the DOK 4 level or the highest level of cognitive complexity.

Discussion of Research Question Two

The second research question was to determine the interaction effects of DOK and LM on student engagement. When the interaction effects are considered, DOK does have an effect on student engagement. In this interaction model, LM does not have an effect any increase in student engagement.

In the two by four factorial with a two way interaction or analysis of variance with interaction the overall effect of DOK*LM does have an impact on student engagement. The simple effects of DOK*LM is only significant at the DOK 1 level. The simple effects of LM, when students are working with others, only occur at the DOK 1 level. At the application level strategic thinking and creating level working with others does not increase student engagement.

The data show that working alone increases DOK at every level using a simple effects model. The data also reveal that student engagement is different at each DOK level and at the DOK 4 level declines when students are in groups.

Between the DOK 1–3 level DOK rises. However, Between the DOK 3 and 4 levels there is a significant drop in student engagement when students are working with others. The interaction model indicates LM is a factor only at the DOK 1 level and increases student engagement only when students are working together.

Implications for educators.

After using a two by four factorial with a two way interaction or ANOVA, implications for educators when DOK and LM are combined, the contribution of LM to student engagement ceases to be significant. In this model LM is only a contributor to student engagement when it is paired with DOK.

While collaboration or working with others is a frequently used teacher strategy, the results indicate that only at the DOK 3 level does LM 2 shows significance in increasing student engagement. Conversely, in the interaction with DOK, working alone is significant and increases student engagement between DOK 1 and DOK 2 and DOK 1 and DOK 3. Data indicate at the DOK 4 level that when are working with others there is a decrease in DOK. Data also indicate there is no significance between recall and creating when working alone. When working alone, recall is significantly different than application and strategic thinking, but not significantly different than creating. When working with others, recall is significantly different than strategic thinking but not significantly different than application or creating.

Discussion of Research Question Three

The third research question purpose was to determine the variances in interaction effect of DOK and LM by educational level and the impact on student engagement. The data shows there are variances in the impact of DOK and LM by educational level. At the elementary level only DOK is significant while neither LM nor the interaction of DOK*LM has significance. At

the middle school level only DOK is significant. LM and the interaction of DOK*LM are not significant. At the middle school level only DOK is significant in explaining variability of the data beyond the constant in the number of students engaged. At the high school level the main effects of DOK and LM and the simple effects of the interaction effects of DOK*LM is significant with DOK. For the high school DOK, LM and the interaction effects of DOK*LM do significantly impact student engagement.

Overall, the data make two clear suggestions about the relationship between DOK and engagement. First, increasing the cognitive complexity demanded of a lesson for students does increase the percentage of students who are engaged with instruction. Second, as DOK level increases, a much larger percentage of students become engaged with classroom instruction. These findings have potentially rich implications for teaching and learning and suggest the effects of teachers using collaboration or working individually to increase student engagement and overall school improvement.

Implications for educators.

Interaction effects of DOK and LM is impacted by the educational level the teacher is teaching. At the elementary and middle school level DOK is significant, while LM is not significant. At the high school level the simple effects results of DOK and LM were significant.

These results, while not addressing the developmental level or developmental learning level of the student, indicate and inform educators, by level, where there is greater opportunity for an increase in student engagement while working alone or working with others. This research values only the impact of DOK and LM on student engagement and does not factor in other areas for pedagogical practice which may impact learning effectiveness or learning results. Overall, the research does support the idea that elementary students will benefit from increases in the

cognitive complexity of thinking and use of cooperative grouping practices that require pedagogical finesse in use and application. However, even at the high school level, parameter estimates indicate that DOK and LM support each other at all levels except at the DOK1 level.

Current Practice

Current general educational pedagogical practices may be different by level impacted by the extent teachers understand student development characteristics and developmental learning (Bronfenbrenner, 1998; as cited in McLeod, 2010). While there may be variances in the complexity of student work by level, there is a continuing preponderance for educators to rely on work sheets and rote memorization, with far fewer examples of students to be exposed to teaching pedagogy that gets at deep and complex learning. This is best exemplified in the data set with 80% of the walkthrough observations classified as DOK 1(36.3%) or 2 (43.7%). Only 20% of the walkthrough observations were at the DOK 3 (15.9%) and DOK 4 (4.1%).

There are many instruments that diagnose the quality of learning for a student through the unfolding of a learning period. Most often the diagnosis process for work complexity is in collaboratively reviewing student work and adjusting the lesson based on this work (DuFour & Eaker, 2010; Marzano & DuFour, February, 2009). What does not change through this process is a diagnosis of how classroom time is used, pedagogy that incorporates motivation, or the relationship between the cognitive complexity flow of a lesson throughout a class period. The typical result of reviewing student work is to try the same teacher practices, but with a continuation of expected student work which was used for the original analysis.

If the value of collaborative learning is used as pedagogy in the classroom without other learning implementation considerations, this research informs the teacher at what cognitive level it is most valuable and at what educational level. As noted earlier, at the elementary and middle

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school level, student engagement does not increase by having students work with others. Even though it is generally accepted that by working with others the impact on mastering the expected skill is greater when there is a cooperative spirit between students as opposed to the teacher delivering the skill expected to be learned. The data does reveal that at the high school level student engagement does increase as the DOK level of the work increases. At the high school level, the simple effects of the impact of DOK and LM have does not differ at the DOK 1 or DOK 2 level is significant and working alone or working with others at this level.

Research in this study found that students who are challenged with complex work make greater academic gains and are more apt to be engaged in the classroom (Wang & Holcombe, 2010; Downer, Rimm-Haufman & Pianta, 2007) This suggests that regular tracking of the lesson's cognitive complexity taking place inside classrooms across a school would provide a teacher leaders with quantitative evidence that students are engaged in the kind of thinking activities that can potentially lead to greater academic achievement across the school. Traditional instructional methods used to assess learning most often consider what the teacher is doing rather than what the student is doing which limits the teacher in understanding the depths of learning taking place in classrooms where students are motivated and the work complex (Fredricks, 2011; Schlechty, 2002; Deci & Ryan, 1985). For example, although a teacher may appear, through formal observations, to deliver competent instruction and even achieve student proficiency scores that suggest the same, how does the teacher know that students are being challenged to think at high levels?

It is suggested those responsible for facilitating the learning environment to plan for effective cognitive flow of a lesson from beginning to end and to determine where in the class period is the most desirous point for the highest level of engagement commensurate with the

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complexity of the learning process occurring. Are teachers focusing on the nature of questions used to facilitate learning (assessment for learning) and the thinking processes germane to an open-ended versus closed question (assessment of learning)? Is there intentionality in how the class is broken into segments with each segment having a pedagogical strategy appropriate for the expected learning to occur? Does the teacher have a teaching plan which keeps them in the facilitative position as opposed to being the single source of the learning that is to occur?

An analogy for a lesson plan could be a road map with detailed directions for arriving at the desired destination. By comparison, lesson plans also provide instructions regarding the teaching of a specific lesson but do not inform on the student's thinking "experience." A larger consideration that challenges the traditional thinking is that a quiet classroom is one where there is a high level of flow in student productivity. In a classroom where students are described as being in the "flow" (Csikszentmihalyi, 1990), the hum of a classroom may indicate high student engagement is due more to the learning complexity than the normal and routine work. Quiet classrooms typically are more characteristic of work engaging students with worksheets, copying words from a source to a notebook, and generally lower level learning activities that promote boredom and intellectual loafing.

While the data from this research only focused on behavioral engagement, the goal is that students are psychologically engaged in the classroom experience. Csikszentmihalyi (1990) describes this as the "flow" experience and describes the experience as one where the student is consumed and lost in the learning experience. Deci & Ryan (1985) describes learning experience as one where the motivation to learn and the experience of being psychologically engaged in the lesson parallel's Csikszentmihalyi's flow theory. Vygotsky (1978) in describing the zone of proximal development (ZPD) connected skill level and challenge how these two

concepts are paired to optimally produce a state of flow. His work was further supported by that of Rogoff, (1990). A huge part of the responsibility to determine this zone is dependent upon the teacher to appropriately match the learning task to the current skill level of the learner; optimally within the student's reach and in their learning zone.

When the teacher's goal is to create a lesson with flow, it becomes imperative for the teacher to create a quality lesson leveled to students' abilities yet challenging and engaging. When the challenge of creating a lesson that promotes an optimal learning experience or flow, distractions to the classroom become minimal. For example, the experience of students being in the flow is when someone walks into the classroom and the students are not distracted from their work (Csikszentmihalyi, 1990; Schlechty, 1997, 2011). The lack of distraction from outside forces for the teacher in the creation of imaginative, creative, lessons initiates the setting for a lesson to move solely from being behaviorally engaging to a lesson that is psychologically engaging.

Using DOK and student engagement results to improve practice.

By establishing the connection between cognitive complexities as interpreted through increases in DOK, the value of gathering rigor data becomes a component part in improving the classroom learning rigor. Persistently schools support focusing on lesson development in making meaning of standards in the teaching process. This research suggests that intentionality in developing the lesson with a cognitive complex focus move the lesson from thinking of just the creation component more to deliberation of delivery of the lesson. With the focus on delivery, the teacher controls the flow of the lesson, manipulation of when to increase cognitive complexity and more rhythmic with the student readiness for cognitive challenge whether working alone or with others.

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This research indicates that when considering working alone or in groups, the educational level (elementary, middle or high school) become important considerations. At the elementary level the interaction of DOK and LM indicate that LM is not a significant factor in increasing student achievement. For example, students working alone at the elementary level tend to show decreases in student achievement at the DOK 1 level, whereas, if students are working in groups at the DOK 1 level there is an increase in student achievement. Conversely, at the high school level, LM does play a role in increasing student achievement. At all levels through DOK 3 and when considering the main effects of DOK and LM, there is an increase in student engagement. However, the main effects at the DOK 4 level for all areas show LM to have divergent impact levels.

At the DOK 4, or creating level, LM has different results. The “creating” level is interpreted that the student is developing a finished personal work such as an original poem, musical lyrics, an explanation bringing together multiple concepts into a position paper, an art product, etc. The impact on student engagement at the creating level is differently impacted by whether students are working alone or with others. When students are working alone at the DOK 4 level, student engagement continues to increase. Conversely, when students are working with others at the DOK 4 level, student engagement decreases and does similarly across each educational level.

At the elementary level any increases in student engagement is dependent upon increases in DOK levels. LM has no impact of increasing student engagement including any interaction value. Further the beta for the interactions of DOK and LM do not reveal any significance at any level of DOK or LM. At the middle school level the results are similar to the elementary level. The significance of the value of LM decreases further. For middle level educators, this would

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indicate the first order in increasing student engagement should rest with the cognitive complexity of the learning difficulty.

The reliance of DOK and LM does change at the high school level with DOK levels impacted by both LM 1 and LM 2. For the teacher this presents an added responsibility in using skill in the delivery of a lesson as to when to have students work alone or work with others. Considering the interdependency of DOK and LM, at the DOK 1 level working alone, unlike the other two levels, does not impact student engagement. At the DOK 3 and 4 levels, Strategic thinking and creating, the teacher must carefully consider when it is best for students to work alone or with others, including consideration of the educational level where collaboration is used.

Limitations

An important part of the DOK, LM and student engagement results rely on accurate data collection. The data collection process relies on individual walkthroughs lasting 1 – 1 ½ minutes. This walkthrough data was gathered from individuals conducting the walkthrough. If time and availability permitted walkthroughs to be done in pairs with a collaborative coding of the results, this would increase the accuracy of the walkthrough report. Moreover, the opportunity to randomly conduct walkthroughs would enhance inter-rater reliability. The current practice is that through the training process, the number of necessary walkthroughs before someone does them individually is to be consistent within one DOK and one in counting the number of students who are disengaged.

The current practice suggests those walking through classes to periodically complete the process with a partner to calibrate consistency. Additionally, the data mean can be distinguished by individuals doing the walkthroughs and once a reliable mean for the grade level, department or school is established. These individual's DOK, LM and student engagement results can be

compared to the larger group mean to determine the deviation from the mean. Ideally, walkthroughs would be done in pairs and these results would be continually monitored for reliability.

Knowledge of recognizing the DOK level of work a student is doing at specific time of the walkthrough is essential. The ability of the trainer to know the difference between Bloom's level of taxonomy (Bloom et al, 1956) and Webb's DOK levels (Webb, 1997, 1999) can impact successful lesson complexity identification.

The inability of an observer to distinguish the cognitive complexity of students working in groups can be a limitation. By presuming students are working in groups at the creating level, observers need to have the ability to acknowledge the differentiated impact on student engagement by whether students are working alone or with others. There needs to be training in the recognize work which is at the DOK 4 level or creating. The data set indicated only nine observations of students working at this level while working with others.

This research only addresses the behavioral engagement of students and recognizes the difficulty in addressing the student who may be staring into space, but working at the highest level or being deep in thought creating or exploring solutions to a problem. The sophistication of the observer to recognize cognitively complex classroom work and to adequately code the student as engaged requires research.

It is suggested caution be used in interpreting a DOK mean synonymously with student effort. The closer companion in increasing cognitive complexity is increases in student engagement. It is through the impact of student engagement that cognitively challenging work plays a related role to student achievement (Szucs, 2014; O'Malley & Hanson, 2012; Wang & Holcombe, 2010). Student achievement becomes the overarching goal for student engagement

with cognitive rigor. Student engagement is the initial classroom focus. It is suggested that achievement results can be backward mapped and interpreted from grade or department level DOK mean. The average level of cognitive rigor taking place in school classrooms can be an indicator of the cognitive complexity of the lesson. Increases in classroom tone or lesson cognitive complexity lead to increases in student engagement which leads to increased student achievement (Szucs, 2014; O'Malley & Hanson, 2012; Wang & Holcombe, 2010).

Collecting Data and Improving Cognitive Complexity

The method described for assessing DOK levels across a school involves the collection of “snapshot” data of students engaged with instruction and the thinking level at which they are working. In this study an adequate number of observations were necessary and determined to be at least 8 walkthroughs per classroom unit or full-time teacher equivalency so as to base conclusions on an appropriate number of walkthroughs. There is an additional need for observers to have consistency in the coding of the cognitive complexity of a walkthrough. The foundation for accurately coding work complexity is best addressed. Further, it is dependent upon the person facilitating data gathering to periodically do walkthroughs in pairs or more to ensure that an observation is identified consistently by the group doing the walkthrough.

The data collection method is a topic for future study that addresses randomization of the walkthrough process. For instance, class walkthroughs lacked variability within the time periods and resulted more for convenience than a clear focus on randomization. The failure to randomize the walkthrough process results in limitations for this study. While a broad brush of classrooms and departments are suggested, the walkthroughs are more at the pleasure of the person conducting the walkthrough than randomly choosing which classroom would be the next to have a walkthrough visit.

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Teachers play an important role in the data collection process. The walkthrough results data can be important to the work of professional learning communities (PLC's). According to Daeschner (2014), the quickest and most effective method to bring the importance of cognitive rigor to the attention of faculty is to get them involved in the data gathering process as it does three things. First, data gathering forces a teacher to fully understand what cognitive rigor is and what it looks like in the classroom. Second, the necessary instructional pedagogy to drive cognitive thinking is observed as lessons are deployed. Third, a sufficient number of observations broaden the teacher's perspective of the school beyond his/her classroom.

Data indicate that of the three educational levels assessed, only at the high school level does DOK, learning mode, and the interaction of DOK*LM increase student behavioral engagement. At the elementary and middle school levels, only DOK results in an increase in student engagement. This suggests that further research is needed in assessing the impact and interaction of these factors particularly at the elementary and middle school levels

This research relied on an observational instrument that is relatively easy to use and generated immediate data. This measurement of cognitive rigor using trained observers in particular when assessing Webb's DOK, requires focused training and inter rater reliability checks to increase both reliability and precision in identifying the DOK level. Further validation studies may be valuable in establishing whether this tool is consistently useful as a cognitive rigor measure.

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