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How do teachers teach students with working memory impairments in the regular classroom? A grounded theory approach

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Graduate Program in Health and Rehabilitation Sciences
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science
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HOW DO TEACHERS TEACH STUDENTS WITH WORKING MEMORY
IMPAIRMENTS IN THE REGULAR CLASSROOM? A GROUNDED THEORY
APPROACH

(Spine title: Teaching Students with Working Memory Impairments)

(Thesis format: Monograph)

by

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Field of Speech and Language Sciences

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

The School of Graduate and Postdoctoral Studies
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London, Ontario, Canada
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THE UNIVERSITY OF WESTERN ONTARIO
SCHOOL OF GRADUATE AND POSTDOCTORAL STUDIES

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**How do teachers teach students with working memory impairments in
the regular classroom? A grounded theory approach**

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requirements for the degree of
Master of Science

ABSTRACT

This study used a qualitative, post-positive grounded theory approach to investigate the process of teaching primary students with working memory impairments. Semi-structured, in-depth interviews were used to collect data specific to students with WMI from nine primary teachers. After transcript coding and data analysis, themes were extracted from the data. The themes reflect how having a working memory impairment may alter the students' education. The interacting themes included: learning with a working memory impairment and the characteristics of the student, adaptations made by the teacher including effective teaching strategies, and adaptations made by the students as a result of their self-awareness of their weaknesses. The students were found to be struggling with the academic curriculum in language, reading, and math. Some students also struggled with their behaviour and social abilities. The strategies teachers used to assist their students with learning included: reducing cognitive load by simplifying material, reducing cognitive load by activating prior knowledge, and focusing attention. Additionally, some students used self-strategies to support their own learning. The findings of this study may inform future research particular to this group, including intervention studies. Additionally, the findings offer important information for educators teaching students with similar learning profiles.

KEYWORDS: working memory, working memory impairments, working memory and teaching, grounded theory, teaching strategies, characteristics of working memory impairments, working memory and classroom

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INTRODUCTION

An estimated 11.55% of students in Canada receive special education programming (Statistics Canada, 2011). Ontario spent over 2.5 billion dollars over the 2011-2012 school year on special education services (School Board Funding Projections for the 2012–13 School Year, Ontario Ministry of Education, 2012). Efforts to understand learning disabilities frequently focus on investigating the underlying cognitive processes implicated in the impairment. One cognitive process found to be highly linked to school learning is working memory, the ability to briefly store and process information (Alloway, 2009). Individual intervention programs aimed at improving working memory have yielded positive preliminary results for increased working memory capacity (Klingberg, Forssberg, & Westerberg, 2002) and improved learning outcomes (Dahlin, 2010). One problem for individual intervention programs, however, is that they are often difficult to translate into teaching strategies effective in the classroom or with groups. In fact, little research has focused on effective teaching strategies for children with low working memory. One important source of information concerning such strategies is teachers who have struggled to teach these children over the course of an entire school year. The present study taps this important resource by taking a qualitative approach to the examination of strategies presently employed by teachers when instructing children with working memory impairments.

What is Working Memory?

Working memory, in its simplest definition, is the simultaneous temporary storage and manipulation of information (Baddeley & Hitch, 1974) and is thought to be a

necessary component of a broad range of complex cognitive tasks (Baddeley, 2003). The concept of working memory was first proposed by Baddeley and Hitch (1974) using a simple, three component model of fluid systems: the visuospatial sketchpad, the phonological loop, and the central executive. In the late 1990s, Baddeley (2000) proposed a fourth component be added to the model, the episodic buffer. The phonological loop and visuospatial sketchpad are domain specific short-term memory components (Baddeley, 2003), while the central executive manipulates the information being stored. The episodic buffer is also concerned with the storage of information and integration of information across multiple systems. Impairments in any of the working memory components may have negative effects on learning, particularly with respect to language (Baddeley, 2003).

The phonological loop briefly retains phonological information and is considered to be composed of two subcomponents (Baddeley, 2003). The first acts to temporarily store presented phonological information, while the second component is a rehearsal mechanism to prevent the decaying of that information. Auditorily presented phonological information has obligatory access to the phonological loop while visual information may be recoded into a phonological form through an articulatory mechanism thereby gaining access to the phonological loop (Vallar & Papagno, 2002). Research has suggested that the phonological loop plays an important role in the acquisition of native and second languages (see Baddeley, 2003 for review). An impairment in the phonological storage component of the loop has been found to correlate with delays in vocabulary development (Gathercole & Baddeley, 1989; Baddeley, Papagno, & Vallar, 1988) and has been consistently reported for children with an unexpected and relatively

specific difficulty acquiring language known as specific language impairment (SLI; Archibald & Gathercole, 2006).

The visuospatial sketchpad integrates spatial, visual and possibly kinaesthetic information for short-term storage (Baddeley, 2003). This component is thought to contribute less to oral language disorders than the phonological loop. The visuospatial sketchpad has been found to play important roles in everyday tasks related to reading (e.g., representation of page, proper eye tracking through text; Baddeley, 2003). The component is also important for grammar as it relates to spatial concepts (e.g., above, below, in, on, behind). For example, individuals with Williams syndrome, a genetic disorder characterized by learning disabilities with relatively strong verbal abilities but impaired visuospatial processing, were found to perform more poorly than age-matched controls on grammatical items related to spatial concepts but not other items (Phillips, Jarrold, Baddeley, Grant, & Karmiloff-Smith, 2004).

The central executive is the limited, attentional control component of the working memory system (Baddeley, 2003). It is thought to include several subprocesses such as temporary activation of long-term memory (Baddeley, 1998), coordination of multiple tasks (Baddeley, della Sala, Gray, Papagno & Spinner, 1997), shifting between tasks or retrieval strategies (Baddeley, 1996), and selective attention and inhibition (Baddeley, Emsile, Kolodny, & Duncan, 1998). Additionally, the central executive has been identified as the primary factor in individual working memory ability differences (Daneman & Carpenter, 1980). These individual differences in working memory have been found to be related to performance in a number of key cognitive domains such as reasoning required for standard measures of intelligence (Kyllonen, 1990), language

comprehension (Daneman & Merikle, 1996), reading comprehension capacity (Daneman & Carpenter, 1980; Baddeley, 2003), and math abilities (Wilson & Swanson, 2001).

The newest addition to the working memory model, the episodic buffer, was originally thought to be a component of the central executive (Baddeley, 2003). Like the central executive, it is a limited capacity system. However, while the central executive is concerned with processing information, the episodic buffer stores information. Unlike the phonological loop and visuospatial sketchpad, which temporarily store sensory information from the external world, the episodic buffer combines stored long term memory information from different modalities into a “single multi-faceted code” (Baddeley, 2003, page 203). The episodic buffer is assumed to be the foundation of conscious awareness (Baddeley, 2002); however research investigating it is in preliminary stages.

Figure 1 illustrates Baddeley’s model of working memory (Baddeley, 2003), which demonstrates the four components of working memory and their interactions.

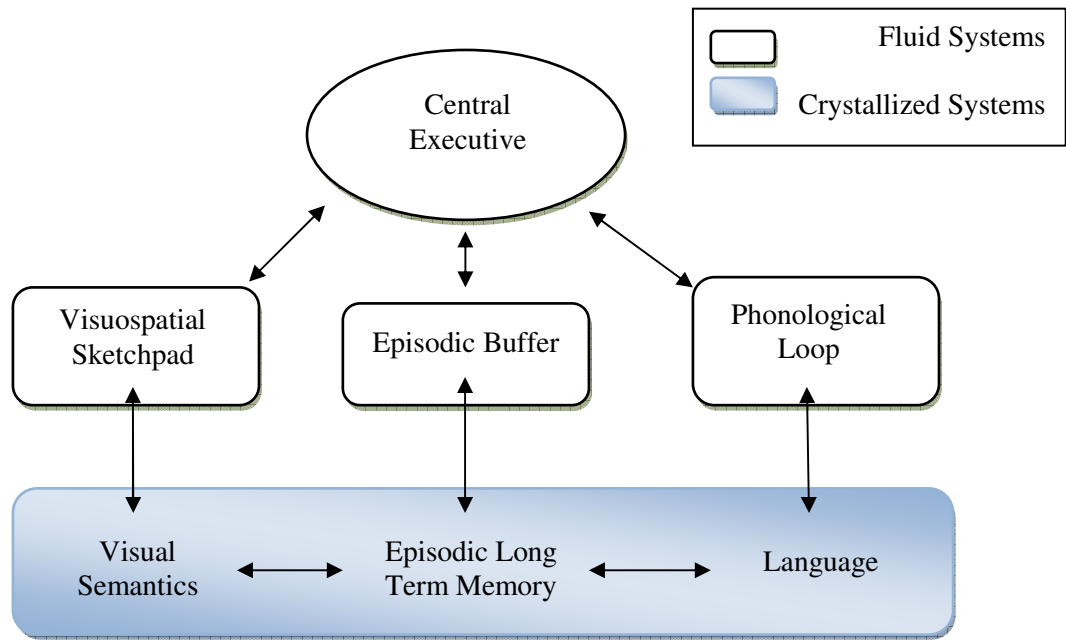


Figure 1 *Baddeley's Model of Working Memory*. This is a recreated diagram from Baddeley (2003). It illustrates the current multi-component model of working memory and how the components interact.

Working Memory Assessment

Assessment of working memory includes tasks that examine the components of Baddeley and Hitch's model (1974), and can be broadly categorized as either short-term or working memory tasks. The tasks involve a span procedure where the number of items to be recalled is gradually increased until the longest list a participant can reliably recall is determined.

Short-term memory tasks entail storage demands only in that participants are asked to repeat items immediately after presentation exactly as they were presented. The tasks do not impose any additional processing or transformation of the information, and as such, are not expected to place demands on the central executive component of

working memory. Short-term memory tasks tap one of the storage components of the working memory model depending on the domain of the to-be-remembered information. Tasks targeting the phonological loop include serial recall of words, letters or digits (Conrad & Hull, 1964), whereas tasks targeting the visuospatial sketchpad involve retention of visual patterns, or sequences of movement (Smyth & Scholey, 1996).

Conversely, working memory tasks impose a significant processing demand in addition to storage. The storage demands of these tasks tap the respective short-term memory systems depending on the domain of the information to be recalled in the same manner described above for short-term memory. The processing demands are considered to tap the domain-general resources of the central executive. A classic verbal working memory task is the reading span tasks in which participants judge the veracity of each presented sentence and then recall the final word of the sentence (Daneman & Carpenter, 1980). An example of a visuospatial working memory task is judging the orientation of rotated shapes and then recalling the location of a marker on the shape (Shah & Miyake, 1996). Importantly, the processing demands of verbal and visuospatial working memory tasks are considered to tap the central executive component of working memory (Alloway, Gathercole, & Pickering, 2006), but performance on these tasks can be influenced by the functioning of the respective short-term memory systems (i.e., either the phonological loop or visuospatial sketchpad). As a result, it is necessary to consider performance across both verbal and visuospatial working memory tasks in order to understand an individual's working memory function.

Recently, two standardized tests have been developed to assess working memory in young children, the Working Memory Test Battery for Children (WMTB-C; Pickering

& Gathercole, 2001) and the Automated Working Memory Assessment (AWMA; Alloway, 2007). Both of these tests include measures of phonological short-term memory (the phonological loop), visuospatial short-term memory (the visuospatial sketchpad), and verbal working memory (the central executive in conjunction with phonological short term memory). The AWMA is a computerized version of the WMTB-C, and additionally includes visuospatial working memory tasks (the central executive in conjunction with visuospatial short term memory). Pickering and Gathercole reported excellent test-retest reliability, and high construct validity for the WMTB-C. As well, performance on the WMTB-C accurately predicts academic outcomes for language development, literacy and math, and can be a useful tool to identify learning disabilities. Pickering and Gathercole were able to correctly identify and classify 81% of students in a sample of 52 7-year-old students by type of disability using the battery. A benefit to using the AWMA over the WMTB-C is the computerized administration, scoring, and interpretation of results as well as inclusion of screening, a short-form and a long-form version of the test. Further, little training is required to administer the battery making it an ideal assessment for teachers (Dehn, 2008).

Working memory measures have an advantage over traditional IQ tests in that working memory measures have not been found to be biased by cultural background and prior knowledge as have some IQ tests (Miele, 1979). It has been suggested, then, that working memory abilities may be tapping a pure learning potential across individuals.

Working Memory Development

Like other executive function processes, working memory develops and improves with age. Evidence suggests that children's ability to implement Baddeley's three part working memory model is established by 6 years of age, and the structure remains unchanged into adulthood. This was demonstrated using a sample of 4 to 15 year old participants given multiple assessments for each component of the three part working memory model (Gathercole, Pickering, Ambridge, & Wearing, 2004). Findings suggested a linear pattern in the growth of working memory, with three distinct but correlated factors corresponding to each component of the working memory model and established by age 6. By 16 years, short-term memory, and working memory are thought to be developed to adult levels of performance, as demonstrated by plateaus with digit span tasks (Hulme & Mackenzie, 1992).

It is widely recognized that a high degree of individual variation exists in the development of working memory capacity over the first 16 years of life. In a large scale study of 3000 children ages 5 to 10 years, Pickering and Gathercole (2001) found considerably variability in working memory abilities among children within any given classroom. It follows from this that in a classroom of 8 year old children, some would have working memory skills equivalent to an average 4 or 5 year old, and some, equivalent to an average 11-12 year old. When considering the range of working memory abilities in the classroom and the provincial standard for teaching students of varying abilities, there is a great demand on teachers to meet the needs of learners with varying working memory abilities in the classroom. Teachers must effectively deliver the

curriculum to typically developing students while individualizing programming for the various skills and abilities of students who fall below academic norms.

Some of the difficulty in investigating working memory development is the challenge in administering appropriate tasks to young children. Children as young as 2 years of age can succeed at simple short-term memory tasks requiring repetition of sounds or locations (Roy & Chiat, 2004). Working memory tasks are more complicated, however, and may not be reliably trained until children are closer to 5 years of age (Pickering & Gathercole, 2001). It is difficult to say whether working memory has not developed prior to this age, or whether we do not have the tasks to assess it prior to this age.

Working Memory Impairment

As discussed above, working memory capacity develops over the first 16 years of life and the course of that development is characterized by a high degree of individual variation. Gathercole, Lamont, and Alloway (2006) found that variance in working memory existed in all regular classrooms for any particular school-aged group with approximately 10% of students falling below typical working memory capacity and ability. Despite this observation, children with low working memory are rarely recognized.

One problem facing our schools today is the difficulty in identifying children with low working memory or working memory impairments. Currently there is a lack of a clear understanding and consensus about what defines a working memory impairment. Some researchers have described children with low working memory skills based on

performance on verbal working memory tasks (Gathercole & Alloway, 2008). One problem with this approach is that verbal working memory tasks additionally tap language abilities, and poor performance on such tasks have been found to characterize children with another developmental impairment, SLI (Archibald & Gathercole, 2006). Archibald and Joanisse (2009) identified children with a specific working memory impairment (SWMI) based on poor performance across both verbal and visuospatial working memory tasks reasoning that consistently poor performance across domains implicates a central executive dysfunction. It is clear that further work is needed to understand how best to identify children with working memory impairments.

According to Gathercole and Alloway (2008), teachers describe students with low working memory as, “making poor academic progress, having short attention spans and high levels of distractibility, failing to monitor adequately the quality of their work, and showing a lack of creativity in solving complex problems” (p. 52); however Gathercole, *et al* (2006) found that working memory impairments often go undetected in the regular classroom and can be misdiagnosed as attentional problems.

This finding is not surprising given the lack of a clear definition for working memory impairments, or a good understanding of the signs and symptoms of working memory impairments. Indeed, checklists of problem behaviours associated with impairments in language (Bishop, 1998), and working memory (Alloway, Gathercole, & Kirkwood, 2008), and attention (Conners, 2005) often include very similar items. The checklists ask generic questions that could identify symptoms of language impairment, working memory impairment or ADHD. For example, each of the referenced checklists

asks if the child has trouble staying on task, has trouble with organization of thoughts and ideas, and has difficulty recalling information.

A study by Alloway, Gathercole, Holmes, Place, Elliott and Hilton (2009) has provided information comparing the identification of students with working memory impairments and ADHD. Results of standardized teacher rating scales including the Connors' Teacher Rating Scale (Connors, 2005) and the Behaviour Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) successfully distinguished most students with working memory impairments from students with ADHD. While both groups presented with attentional deficits, the students with ADHD tended to be more oppositional and hyperactive while students with working memory impairments were likely to be inattentive.

Working Memory and Education

Working memory can be thought of as a mental workspace for important everyday activities (Alloway, 2009). In understanding the four components of Baddeley's working memory model, one can begin to appreciate the relationship between working memory and learning. As mentioned above, working memory has been found to be highly related to different forms of learning such as language acquisition and processing (Baddeley, *et al.*, 1988; Gathercole & Baddeley, 1989), reading (Baddeley & Wilson, 1993), spatial awareness (Phillips *et al.*, 2004), and other complex, cognitive, everyday tasks (Pickering, 2006). Much research has focused on working memory as it relates to children's learning and the results have profound implications for education.

The relationship between working memory and learning has been known for some time. In 1980, Daneman and Carpenter found that differences in reading comprehension ability were linked to differences in working memory. A decade later, Kyllonen (1990) found a similar relationship between working memory and reasoning ability. Since these earlier studies, many studies have found a strong relationship between working memory and school performance (Alloway, 2009; Passolunghi, & Seigel, 2004; Swanson, 1993).

Working memory ability has also been found to be a strong predictor of school outcomes over a longitudinal period. Alloway (2009) tested 37 children with learning disabilities in literacy, numeracy, intelligence (IQ) and working memory, and retested the students two years later. Results revealed that working memory was a superior longitudinal predictor of overall school outcomes over traditional IQ testing. Other researchers have reported similar findings (Cain, Oakhill, & Bryant, 2004; Gathercole, Alloway, Willis, & Adams, 2006). Students with higher working memory abilities were more likely to do well in school while students with low working memory were more likely to do poorly.

Other research has linked learning disabilities to specific working memory deficits. Passolunghi and Seigel, (2004) demonstrated that students with math disabilities have a general deficit in the central executive component of working memory, but not in the rehearsal mechanism of the phonological loop. Further, Alloway, Gathercole, Willis, and Adams, (2005) found that working memory impairments of identified learning disabled students varied according their special education requirements. That is, students with varying learning disabilities displayed deficits in different components of working memory. For example Alloway *et al.* were able to demonstrate how students with reading

disorders seem to have low verbal short term memory and verbal working memory, whereas a student with ADHD has average short term memory, but deficits in verbal working memory and visual-spatial working memory. In her 2009 paper, Alloway suggested reasons for working memory's relation to learning and its predictive power. Working memory is important for holding relevant information in mind while completing necessary cognitive processing or reasoning. Working memory is also important for integrating acquired knowledge with new information to scaffold learning. If children are limited in the amount of information they can hold in short-term or long-term memory, then naturally they will have more difficult time learning. Students with working memory impairments are unable to hold sufficient information to complete tasks and therefore struggle to achieve normal academic progress and rates of learning.

Considering roughly 10% of students fall below typical working memory ability, working memory has important implications for the current educational pedagogy of inclusive education and differentiated instruction (Ontario's Equity and Inclusive Education Strategy, Ontario Ministry of Education, 2009). Inclusive education describes a pedagogy where students of varying ability levels have equal rights to education, and are taught in the same, regular classroom with the special support services required to reach their academic potential. Differentiated instruction is the accepted teaching practice used to individualize programming for the array of abilities in a classroom (Ontario's Equity and Inclusive Education Strategy, Ontario Ministry of Education).

Working Memory and Intervention

With this new found knowledge about the important relationship between working memory and learning (Alloway, 2009) comes exciting evidence that working memory capacity can be improved with intervention (Holmes, Gathercole, & Dunning, 2009). For example, interventions with students with ADHD have shown the potential to improve working memory and aid students in attending better to listening tasks (Holmes, Gathercole, Place, Dunning, Hilton, & Elliott, 2010). Further, an intervention study by Dahlin (2010) investigated the effects of working memory training for students with reading disabilities. Overall, the working memory intervention helped students improve reading comprehension, but did not improve phonological decoding skills or orthographic verification. This knowledge has profound implications for improving education for students with exceptionalities (i.e., learning disabilities).

Although great strides have been made in developing individual interventions for working memory, relatively few resources are available for teacher education. Gathercole and Alloway (2008), and Gathercole, *et al* (2006) offer comprehensive guides for teachers that summarize research regarding working memory and learning, as well as offer some theoretically based teaching strategies for students with working memory impairments in the regular classroom setting. These strategies include: recognizing working memory failures, monitoring the child, evaluating working memory demands of learning activities, reducing working memory demands when necessary, repeating important information, encouraging the use of memory aids, and developing the child's own strategies for supporting memory. However, strategies derived from theoretical and research knowledge may not translate easily into application in the classroom.

The lack of classroom level resources available to support children with working memory impairments in the classroom is problematic for many reasons. Inclusive education or mainstreaming has been the primary educative pedagogy since the 1980s (Rose, 2010). Inclusion is the process by which students with disabilities, or exceptionalities, are integrated within the regular, general classroom with their peers (Scruggs & Mastropieri, 1996). This means that all general education teachers are responsible for understanding all exceptionalities (i.e. learning disabilities, ADHD, autism spectrum disorders, etc.), and how to teach students with exceptionalities in the general classroom. Moreover, the requirement of teachers in Ontario is to use differentiated instruction to individually program for each student and his or her particular learning needs (The Individual Education Plan: A Resource Guide, Ontario Ministry of Education, 2004). This requirement, in addition to meeting curriculum expectations, is already a great demand for teachers, making the implementation of new theories or strategies potentially difficult. Research must therefore translate knowledge into practical and feasible strategies for use in the classroom. A necessary first step is for researchers to understand what teachers are already doing in their classrooms to assist students with working memory impairments.

Pickering (2006) states that there is a “growing interest in applying detailed theoretical knowledge about cognition, and in particular the study of working memory, to our understanding of how children perform in educational settings” and follows this by stating that, “there is no one place where information [of working memory and education] exists together” (page xv). Baddeley (2006) adds to this in writing “those studying the cognitive psychology of learning and memory have tended to stay relatively close to the

laboratory, and as far as I can ascertain, those studying education stay relatively close to the classroom” (page 1). Furthermore, she states that there is a lack of expressing understanding in this field in a way which speaks to both education and psychology.

In response to the identified research gap, the present study uses a qualitative methodology to address the research question: *How do teachers teach students with working memory impairments in the regular classroom?*

One valuable resource available to us regarding this research question is teachers themselves. Over the course of a year teaching a child struggling to learn, a teacher learns much about effective teaching strategies that can be used in an individualized manner to aid struggling students in their classroom.

Since there is currently minimal knowledge about how teachers go about effectively teaching students with working memory impairments in the classroom, a qualitative approach was used for this study. Specifically, the chosen methodology was post-positivist grounded theory (Corbin & Strauss, 2008). Qualitative studies allow for the collection of rich, descriptive data that provide researchers with a broad view of the complexities of the issues to be studied. Additionally, grounded theory allows for researchers to investigate a topic where relatively little is known, and develop theoretical constructs of occurring themes (Corbin & Strauss).

This methodological approach is unique in the field of working memory research as it relates to education and teaching strategies. While qualitative methodologies are practiced in both the fields of psychology and education (Mertens, 2009), a literature review identified only one study specific to psychology, education *and* working memory. This study, by Gathercole *et al.* (2006), used a mixed methods design to present the

profiles of three children identified as having poor working memory. The researchers complimented standardized test scores with qualitative observation and analysis of routine classroom activities aimed at identifying learning situations in which working memory demands were expected to have consequences for task completion. In contrast to Gathercole *et al.*, the present study focused on effective teaching strategies rather than activities with high working memory demands.

The aims of this study were two-fold. First, the study was designed to, “discover rather than test variables” (Corbin & Strauss, 2008). Currently, there is a lack of knowledge in the literature focusing on observational details and descriptive profiles of the learning challenges experienced by students with working memory impairments. Before implementing intervention strategies, it is ideal to understand this phenomenon as it occurs in a child’s life in the classroom every day.

Second, this study aimed to inform by inductively investigating how teachers teach students with working memory impairments, and develop theories based on the findings. This includes any components of the students’ characteristics and learning that teachers feel are important.

METHODOLOGY AND METHODS

Study Design

For the research question ‘*How do teachers teach students with working memory impairments?*’ a qualitative approach was taken. Qualitative research can be defined as naturalistic and descriptive research concerned with understanding processes and building theories inductively (Bogden & Biklen, 2007).

Grounded theory was the chosen qualitative methodology. Grounded theory was first developed in 1967 by Glaser and Strauss for the purpose of theory development. In current grounded theory practices, the methodology is used in areas of literature where little is known to generate theoretical constructs derived from collected data (Corbin & Strauss, 2008). Data is to be closely informed by actual events and interactions of people in the *real world* setting (Holloway & Todres, 2003). Theoretical derivatives may then inform directions for future research. The approach therefore works well with the present research question since little is known about how teachers are currently teaching students with working memory impairments in the regular classroom.

A post-positive paradigm was adopted to investigate the research question as the nature of the information is purposeful and factual. Post-positivism is the philosophical position taken by the researcher. The position is objective in nature, with an understanding that there likely is not one explanation of knowledge that may explain a phenomenon (Finlay & Ballinger, 2006). The post-positivist paradigm also allows researchers to recognise the challenge of studying a complex social world that cannot solely be reduced to quantitative measures (Finlay & Ballinger).

The postpositive paradigm suited the research question and methods by guiding objective, and directed semi-structured interviews. Semi-structured interviews were directed in that questions were asked with the aim to answer the research question; however the structure was not fully defined leaving opportunities for teachers to speak about items they felt were noteworthy and important to the data. In this manner, assumptions are not made about the potential findings in a way that may influence results, and the teachers were free to respond in ways meaningful to them.

Using the post-positivist lens, this research was conducted from the ontological perspective of critical realism (Lincoln & Guba, 2003). This means the belief of the researcher is that there is a *real* reality of a particular phenomenon; however it can often only be studied imperfectly. To unearth the reality of knowledge researchers must investigate from several angles to reach the *best* theory (Lincoln & Guba).

When this ontology is put in the context of the current research project, the ontology explains that there is thought to be a real reality of how to teach students with working memory impairments such that these students can successfully learn within a regular classroom. Given this, there is likely no one approach to teaching students with working memory impairments that will meet the needs of all individuals. The research could, however, give educators a general understanding of how to approach working memory impairments in the classroom.

The epistemological perspective of a post-positivist researcher is that of objectivism (Lincoln & Guba, 2003). This means that the reality and truth of how to teach students with working memory impairments is external to the personal thoughts and beliefs of the researcher. To discover these truths the researcher must be reflexive (i.e.,

aware) of personal attitudes and beliefs throughout the research process such that they can be separated from the data provided by the teachers. The researcher's thoughts and feelings about the topic should not be included in the interpretation of the data. There are other forms of grounded theory where this is not the accepted paradigm, and the researcher is invited to use his or her perceptions to *construct* theoretical meaning (Charmaz, 2006). Given the nature of the present research question, other paradigms were not considered as well suited as post-positivism.

Reflexivity and Memo-Writing

Reflexivity is considered an essential part of the qualitative research process (Corbin & Strauss, 2008) and can be defined as, “[the] self-aware, critical reflection of the ways in which the researcher might have influenced the objectives, process, and outcomes of the research” (Finlay & Ballinger, 2006, page 262). Reflexivity was used as a methodological tool throughout this study to maintain researcher objectivity.

Memos are written records of analysis kept by the researcher pertaining to analysis and theory development (Corbin & Strauss, 2008). Memo-writing was employed as an analytic tool throughout the data collection and analysis. The memos' functions were paramount in the process of this grounded theory project, and they contributed in all ways to the resulting themes and their objective interpretation.

Quality Criteria

Ballinger (2006) offers four considerations from which one may evaluate the quality of a qualitative study. Her considerations acted as a guideline throughout the research process. The four considerations include: coherence, evidence of systematic and careful research conduct, convincing and relevant interpretation, and role of the researcher being accounted for. Described are Ballinger's definitions for each criterion and descriptions of how they were considered for the current study.

Coherence is the matching of research elements to the adopted epistemological approach of the researcher. Study design, and decisions throughout the research process were guided by the epistemological perspective of objectivity as dictated by the post-positivist paradigm. Peer-reviewed research was used to guide the study.

Evidence of systematic and careful research conduct occurs when the researcher is transparent throughout the research process. This includes using detailed explanations of the research process in its entirety. It also includes providing several rich quotes from the data such that readers can understand interpretations, and how a theoretical model was developed.

Convincing and relevant interpretation describes the plausibility or face validity of the study. Interpretations of the data should fit with related, known knowledge and make significant contribution to the literature.

The Role of the researcher accounted for relates to the role of the researcher throughout the research process. In the post-positivist paradigm there is no role of the researcher and therefore he or she must employ reflexivity to maintain researcher objectivity (that is, be aware of one's own thoughts and feelings and isolate them from

what the data describes; Corbin & Strauss, 2008). Thick descriptions (participant quotes) and an audit trail (thoughts or interpretations throughout analysis; Corbin & Strauss) were used to maintain then demonstrate the objective role of the researcher in this study.

Participants

Nine teachers of children with persistent working memory impairments participated in the present study. All teachers taught in the primary division (grades 1-3), were female, and ranged in level of teaching experience from less than one year to greater than ten years. The children were in the primary division (grade 1-3), with an age range of 7 years, 4 months to 9 years, 2 months with a mean age of 8 years, 0 months (SD = 6.47 months). The children with working memory impairments had previously participated in a larger, longitudinal investigation examining language, working memory, and academic achievement (Archibald, Oram Cardy, Joanisse, & Ansari, in preparation). Of the 13 students identified from the database, parents of 11 agreed to allow their child's teacher to be interviewed as part of the study. Of the 11 teachers approached, nine consented to participate in the study.

All of the children had completed a battery of standardized tests at both 13 months prior to the study and again at 1 month prior to the study. The *Automated Working Memory Assessment* (AWMA; Alloway, 2007) was administered as a test of working memory. The AWMA includes twelve subtests, 8 of which were administered in the present study. Two subtests targeted each of phonological short-term memory (recall lists of digits, or nonwords), visuospatial short-term memory (recall locations of dots, or blocks), verbal working memory (recall tallies of digits, or final words after counting or

processing a sentence, respectively), and visuospatial working memory (recall location or orientation after identifying a different shape or mentally rotating an image, respectively).

For the present purposes, a working memory composite was calculated as the average score of the 4 working memory measures for verbal and visuospatial working memory.

The 4 measures are described in Table 1.

Table 1

Summary of Working Memory Measures

Task	Target area of Working Memory	Description
Listening Recall	Verbal working memory	Students must listen to a short sentence and decide if it is true or false. At the end of a series of sentences (dependent on level of difficulty), students must recall the last word of each sentence in the order they occurred.
Counting Recall	Verbal working memory	Students are shown an array of triangles and circles with varying attributes. Students must point to and count out loud the number of red circles in each array. Following the arrays (number depends on level of difficulty), students must recall the number of red circles in each array in the order they appeared.

Odd-One-Out	Visuospatial working memory	Students are shown 3 shapes with one being the different, or odd-one-out. Students must first recognize which shape is different. Following a series of sets (dependent on level of difficulty), students must remember where each odd-one-out shape was in the order they appeared.
Spatial Span	Visuospatial working memory	Students are shown a shape, then a second version of the shape that may be rotated and/or flipped. With the shape, a small red dot is presented in one of 3 positions. Students must identify is the shape is the same as the original, or flipped. After a series of shapes (dependent on level of difficulty), students must recall the location of the red dot from each shape in the order it appeared.

The children also completed two subtests from the Weschler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) as measures of general nonverbal intelligence. In *block design*, children are asked to recreate an image using red and white patterned block in a given amount of time. In *matrix reasoning*, students are presented with a series of pictures. They then have to choose from 4-5 answers which image best fits with the given

item. The performance intelligence quotient (PIQ) was calculated based on the test norms for these 2 measures.

Children were considered to have a persistent working memory impairment if they met the following criteria: (1) a working memory composite score more than 1 SD below the standardized mean (<86) at both testing periods, and (2) PIQ score within or above normal range (>85) at both testing periods. The teachers did not know the children had been identified as having a working memory impairment, nor were they privy to the students' PIQ scores.

Importantly, a difference of 1 SD is conventionally considered to be a large effect (Cohen, 1959). Only these standardized test results were used to identify the children. No information was gathered regarding the child's status at school, for example, whether they were identified as a child with special learning needs or on any alternate curriculum. As a result, the children were considered '*non-identified*' for educational purposes in the current project. One student had been recently identified by the school. This occurred 3 months prior to this study and was not known by the researcher until the time of the interview.

Although the students were not directly involved in the study as described above, they were key to identifying the teachers who did participate. Selection of participants in this manner constitutes purposeful sampling, that is, sampling particular participants to interview regarding a specific topic in order to address the research question (Corbin & Strauss, 2008). By purposely sampling from children with persistent working memory impairments but average intelligence, the findings can be attributed to the child's deficit in working memory ability, rather than their inherent intelligence.

Letters of information were provided to all parents, principals, teachers and students (Appendices B & C), although written consent was not required from principals. Students did not directly participate in this study; however the researcher took time to explain the study to each child being discussed by their teacher and assent from each child was obtained.

Data Collection

Data was collected through in-depth, semi-structured interviews. In-depth interviews are a suitable data collection method for grounded theory as grounded theory methods and intensive interviewing are open-ended with direction (Charmaz, 2006). That is, teachers were asked to speak of particular aspects of their students' learning; however specifics of what they chose to discuss were open. The semi-structured style of interviewing is not set by specific questions (Corbin & Morse, 2003); the goal is to maintain a specific topic for discussion. This acts as an ideal and rich data source since teachers are able to speak openly and in great detail about their observations and interpretations of what they experience with students freely.

Interviews took place at each teacher's school either after the school day, or during a preparation or break period in the teacher's schedule. Interviews were audio recorded and ranged in length of time from 34:05 to 51:45 minutes. The focus of each interview was the identified child.

Initially *guiding questions* were used to guide initial interviews and help with initial interviewing. Objective interpretations were then used to shape consecutive interviews to target potential emergent themes. Questions in later interviews were based

on the evolving analysis, and were tailored to be more specific to emergent themes developing from the constant comparative analysis (i.e., analysis occurring at the same time as data collection; Corbin & Strauss, 2008). Saturation was reached by the ninth teacher interview meaning that no new themes were emerging from the data and data collection could be discontinued. Upon data saturation, categories (i.e., themes) could be developed into their properties, and dimensions and relationships (interactions) could be drawn between them to construct a theoretical model of how teachers teach students with a working memory impairment (Corbin & Strauss).

On two occasions, teachers were contacted through e-mail to address questions with respect to clarifying ideas or comments made in the interview. Some of these questions were e-mailed to address gaps in the evolving data analysis not visited in earlier interviews. For example, in later interviews extra help from the learning support teachers was mentioned but not discussed in an earlier interview. The teacher from this interview was contacted by e-mail to address this. Maintaining communication in this manner assisted with the time sensitive nature of this study as interviews had to be completed after the second testing period for students occurring in early spring and before the summer holidays.

While many qualitative analyses include multiple interviews per participant (Mason, 2002), one was sufficient in this study to reach data saturation. This was perhaps due to the narrow focus of the research question, or due to the breadth of similarities that existed between interviews.

Data Management

Data were transcribed by the primary researcher using scribing software, InqScribe, (Inquirium, 2011), then checked for accuracy by listening to the audio file and reviewing the document. Identifiable information was removed, and audio files and transcripts were encrypted.

Analysis

Consistent with the paradigm of this study, the data analysis process was informed by Corbin and Strauss (2008). Data analysis was exploratory in nature and occurred simultaneous with interviews. All interviews occurred during the final two months of the school year meaning that there were restrictions with respect to transcribing interviews in the allotted time. Multiple listens to interview recordings and detailed memo-writing assisted analysis of interviews before coding commenced. This process assisted in developing early categories and shaping following interviews.

Once transcribed, transcripts were coded using the software program NUD.IST Vivo 9 (Nvivo; QSR International, 2007; Walsh, 2002). Transcripts were first coded into initial codes, a means to organize data into the major topics of the interviews. Following initial coding, focused, axial and theoretical codes followed, respectively.

Initial coding is instinctual, and places a generic label on a portion of the transcript (e.g., regular classroom routines, difficulty decoding words; Corbin & Strauss, 2008). *Focused* coding looks for similarities and differences amongst the most significant and/or frequent initial codes to categorize large quantities of data and further group the

data (e.g., difficulty decoding words and difficulty with reading comprehension were grouped into *Reading Characteristics*; Corbin & Strauss). *Axial* coding is used to disaggregate initial codes and formulate categories and sub-categories (Corbin & Strauss). This form of coding was used to rearrange codes into more inclusive categories (e.g., reading strategies and math strategies are categorized into *Strategies*). Finally, *theoretical* coding is used to build a theoretical model from emergent themes or categories (Corbin & Strauss). Theoretical coding was used to identify the main themes that emerged from the smaller categories to construct a theoretical model of major themes and their relationships with one another.

Constant comparative analysis was employed, meaning that each incident in interviews was coded and then compared with other incidents for similarities and differences (Corbin & Strauss, 2008). Throughout, and following the coding process, categories, or themes, were extracted and diagrammed to display their interactions. The components of these themes and interactions evolved as the data were analyzed until the resulting relationships emerged. Throughout the analysis process, reflexivity and memo-writing was practiced by the researcher.

Results

This section discusses detailed results from the nine interviews that occurred with the teachers of students with working memory impairments and average nonverbal intelligence. Teachers were not made aware of students' performance on the identifying standardized tests, nor did they know their student had been identified by the researchers as having a working memory impairment.

Teachers in eight of the nine interviews reported concerns regarding the targeted student, and described the learning characteristics of this student as different from classmates. The teachers were also able to discuss special programming targeted to meet the individual needs of the students. From these conversations, a model of how learning with a working memory impairment can be conceptualized was constructed.

In contrast to other teachers' reports, one of the nine teachers interviewed reported no concerns with her student. This particular student stood out as being one of the top in the class, and a model student compared to peers. For this reason, this student was not included in the data analysis. Further consideration of this finding will be addressed in the discussion.

Overview

Through inductive data analysis of the in-depth interviews with teachers, a conceptual model of what it is like to learn with a working memory impairment was developed. This model seeks to illustrate the dynamic aspects of learning with a working memory impairment and includes interacting themes that transpired from the interviews and centered around the central category of having a working memory impairment. Based

on the data analysis, the themes occur in response to the presence of a working memory impairment with the student in question. The themes interact with each other as well as with the presence of the impairment itself. Figure 2 provides a graphic depiction of this model. The following section describes the model generally, and then the data analysis leading to the identification of these themes are presented.



Figure 2. *Conceptual model of learning with a working memory impairment.*

Components of the Conceptual Model

The relationship between the central category, emergent themes, and the data has been described using an umbrella analogy Corbin and Strauss, (2008). In this analogy, the central category would be the pole attachment where each spoke originates. The spokes are the major themes and subthemes that have emerged and interrelate, while the data are the fabric that holds the spokes together to complete the functional purpose. The central

category connects each component together, while the themes branch and are made functional and relevant by the data provided by the teachers in their interviews.

Central category

The central category is the main theme and has the highest explanatory relevance to the research. Its function is to link other themes together (Corbin & Strauss, 2008). In this study, the emergent central category is *Having a Working Memory Impairment*. This central category meets Corbin and Strauss' criteria for a central category: it is abstract; other major themes relate to it; it is logical and consistent with the data; it is sufficiently abstract to be carried into other research on the topic; and it displays depth and explanatory power to each of themes and subthemes. Simply, the three major emergent themes emerge directly from the central category in this model, the presence of a working memory impairment. The impairment is responsible for the unique characteristics of the students, teachers' recognition for extra support and strategies, and the students' academic struggles compared to peers.

Emergent Themes

Learning with a Working Memory Impairment

The theme of learning with a working memory impairment includes distinctive characteristics displayed by the students. While many or all of the students with working memory impairments shared some characteristics, other characteristics were unique and specific to one or few students. The characteristics shared are those the teacher felt distinguished them from their classmates. These characteristics also impacted the way students learned and/or how they socialized and behaved in the classroom setting. Many of the

characteristics discussed were thought by teachers to contribute to these students falling behind in class and making slower gains than peers.

Adaptations made by the Teacher

In response to students with working memory impairments making slower gains than peers and falling behind in class, teachers adapted their instruction and teaching style for that individual. Strategies among teachers varied, but often focused on reducing cognitive loads on students and offering extra support in task specific ways. Adjustments to teachers' instruction were guided regularly through interactions or conferencing with the student with a working memory impairment.

Adaptations made by the Student

Many of the students in question were aware of their academic weaknesses. This self-awareness resulted in the student developing some of his/her own strategies for coping. While some of these strategies were shared, many were specific to one student.

Summary of Emergent Themes and Subthemes

The following sections offer detailed explanations of the resulting themes that emerged from the interview data analysis. Names of teachers and students have been removed and they are instead referred to by the same corresponding letter (e.g. Ms. X taught Student X). Table 2 below summarizes these themes with their categories and subthemes. Note that in the results, teachers are often referred to as using specific strategies for their students with working memory impairments; however this is only for the purposes of explaining the data. Teachers were not aware their students had been

identified as having a working memory impairment, nor were they selecting specific strategies for working memory.

Table 2

Summary of Emergent Themes

Categories	Subthemes
Part 1: Learning with a Working Memory Impairment	
	Social Characteristics
Non-academic Characteristics	Behavioural Characteristics
	Family and Home Life
	Literacy Characteristics
Academic Characteristics	Math Characteristics
	Attention and Memory Characteristics
Part 2: Adaptations Made by the Teacher	
One on One Support	
Building on the Basics	
Extra Practice and Repetition	
Prompting	
Chunking of Information	
Checking for Understanding	
Student-Teacher Conferencing	
Minimizing Distractions	
Teaching Students to use Tools	
Positive Reinforcement and Building Self-Esteem	
Play-Based Learning and Making Material Meaningful	
Accommodation and Modification of Assignments and Assessment	
Modelling	
Part 3: Adaptations Made by the Student	
Learned Strategies	
Self-Developed Strategies	

Part 1: Learning with a Working Memory Impairment

Non-academic Characteristics

During the interviews, teachers were asked to describe what it was like to have the student in question in their class. In addition to academic characteristics, teachers felt it important to disclose detailed descriptions of all aspects of the student, such as personality traits and *social characteristics, behavioural tendencies, and family or home life*.

In terms of *social characteristics*, some teachers had little-to-no concern about the students' social development. Student C, D and H were described as being well liked by peers, fun, energetic, easygoing and simply genuine, nice children. Ms. D shared the following,

[Student D] has, you know, the best heart... [Her strengths] are helpfulness and, you know, her willingness to try anything and she gets along with everyone. You know, she's just generally very sort of bubbly, and helpful, and pleasant." (Ms. D)

When discussing Student C's book choices, image amongst peers and popularity came up as an issue,

He struggled with choosing good fit books for himself the whole year and I think it had a lot to do with image. Um he's a pretty cool kid. He's got lots of friends, he plays hockey, he's taller than the other kids, he's older than the other kids - he's a January baby. Um, so he's I think... is he a January? Anyway, he's one of the oldest kids in the class and I think that that um... he really needed to like personify that and so he didn't want to show that he was reading baby books, if you know

what I mean. So he would choose higher level books that weren't appropriate for him to cover that up. (Ms. C)

Interestingly, other students seemed to struggle socially and their teachers suspected this might have been due to weakness in their ability to remember and/or logically sequence events. Peers seemed to notice that these students weren't interacting in a "normal" manner. For example, Ms. G described Student G's elaborate story telling as a reason for peers to alienate her,

She will often tell stories that aren't true, and exaggerate on things, and that, um, due to you know, the students kind of realizing that, they were starting to alienate her a little bit. So, and she she didn't kind of connect the piece, that her story telling was pushing kids away as far as their interest in her and who she was
(Ms. G)

Ms. G also described how Student G's event recall has caused some isolation from peers. She said the following when asked how Student G would describe her weekend, "It starts off pretty, you know, 'I went here, there'; however Student G's stories are not sequential, "[She] gets caught up in going in different directions and maybe not sticking to what a normal child would say."

Ms. B, E and A also made mention of their students inability to properly sequence the retelling of events, but their descriptions were more specific to literacy than social interactions with peers. This will therefore be detailed in the *Academic Characteristics* section.

A second social characteristic teachers felt negatively impacts their students' interactions with peers was their inability to read and interpret social cues. Ms. A, B, C,

E, F and G all commented on this with respect to their respective students. This was a primary focus of Ms. E and F's interviews and so their comments are included below,

Sometimes he needs a lot of assistance; you know to remember [appropriate reactions and problem solving] (Ms. E)

Sometimes he over reacts, and so that makes kids tease him a bit. You know? Like he'll he'll sometimes get really really upset, but because he's sort of putting on a show, the kids don't know how to take it and then they'll laugh and make it worse, so you know I've just said to him to [remember the strategy] – wait and cool off. (Ms. E)

He plays but, his form of play is really um, what's the word? Not immature, but just child, childish (Ms. F)

Sometimes [the other students] can't stand stuff. Like, you know, the, he'll be very in their space. He's got a big problem with personal space, but for the most part he's pretty good with them. (Ms. F)

With [Student F] it's always... you don't know what to expect with him. You don't know what he's thinking. He'll have his good days, but then he'll have um..... some rough days and the rough days are usually social behaviours too. It's a lot socially. Like he just doesn't know how to play fair with kids, like everything is about him (Ms. F)

While many similarities can be drawn among students' social characteristics, students varied greatly in their *behavioural tendencies*, and *family or home life*.

Behaviour profiles of the children ranged from not being an issue within the classroom,

to being the focus of Ms. F's intervention strategy prior to dealing with academic concerns,

He just doesn't get it. Like I don't know what the process in thinking is, but he doesn't get things that much. Like he just thinks like it's all fun. He he's very.... like with learning, I'd say his learning style, if he doesn't want to do it he'll cause like a scene, and it's really really distracting to the other kids. He'll be like "No! I don't want to do it, this is stupid, I hate this, I hate school", so he gets like oppositional, like defiant sort of and, as a teacher dealing with kind of like the other 20 students in a classroom... my, my best thing is to not even fight it, cause if I talk back he'll talk back to me and then you take away from the others. You waste so much time arguing with him, so sometimes you just have to ignore it, and then I get it done with him alone on a 1 to 1 basis. (Ms. F)

While the behaviour of Student C is also of concern, it is less drastic in comparison to Student F's. His behaviour was, however, an important aspect of his dynamics as a student since Ms. C chose to discuss it in her opening comments,

He tends to, he doesn't have much of a filter, so he tends to speak out, um he tends to pretty much say whatever happens here (points to head), comes out here (points to mouth). Ummmmm, before he can even think about it.... (laughing). So he's very impulsive, um so I found it difficult to um, maintain flow in my teaching when it was sort of peppered with comments from the peanut gallery. (Ms. F)

Other teachers' comments regarding behavioural tendencies of their students were focused on inattentiveness and attention. Inattentiveness and attention is discussed in the *Academic Characteristics* section.

Like behavioural characteristics, *family and home life* also varied among the students. Based on teacher reports, students came from a variety of socioeconomic backgrounds and families put various levels of importance on academic success. Teachers' perceptions about the importance of academics stressed by the family seemed to vary on a spectrum. The family of Student C seemed to be making the greatest efforts to address their concerns for Student C's academic progress. Mrs. C reported that the family participated in, and supported school intervention programs to increase Student C's academic performance and learning. Additionally, they participated in literacy based extra-curricular programming.

Contrary to the family of Student C, Ms. H believed the family of Student H placed little importance on academics. Ms. H described his family as loving and supportive; she also mentioned that the family did not seem overly concerned with Student H's slow academic progress. Little attention was given to homework or at home literacy programming. Ms. H mentions, "I'm not sure um.... support other than school, I don't think he's receiving it and so uh... what he gets at school is all I think he gets academically... um... and so that's that's it.... right?". Instead, Student H spent most of his home time playing outside with other children, which Ms. H suspects is a contributing factor to Student H's social strengths and popularity among peers. Overall, the stress of importance on academics by families in this study ranged between these two extremes for other students.

Overall, the students discussed varied greatly in their behavioural and family life characteristics, as well as in their socioeconomic backgrounds. In contrast, their social characteristics exhibited several similarities, which some teachers attributed to cognitive abilities.

Academic Characteristics

A large portion of interview time was spent discussing the academic characteristics of the identified students with working memory impairments. In contrast to the non-academic characteristics, there are many more similarities that can be drawn between the academic characteristics of these students.

Overall, teachers were concerned for the academic progress of the students in question, and some were admittedly baffled by their unique students. Ms. B, D, E, F, and G all made reference to ‘layers’ of the students, explaining that, as teachers, they had never before seen students like these with so many layers to their learning difficulties. Ms. D summarizes, “There’s like a vision thing, and there’s a hearing issue, and there’s you know, the decoding, and the spelling, and the printing, there’s a lot that she has to deal with.”

Teachers also commented on the students’ learning with respect to more specific areas of the curriculum. Academic characteristics discussed include literacy (reading and writing), mathematics, and attention and memory. While not all students exhibited exactly the same learning profiles and are at different levels with their knowledge and skills, all seemed to struggle with similar aspects of learning. Additionally, in terms of

academic ability level, all students were reported to be one to two years behind grade level. The following sections include further details.

Literacy Characteristics

Reading

A large portion of interviews focused on reading characteristics and abilities of the students. This was potentially because, as most teachers expressed, low reading abilities were limiting the academic progress of these students in other areas of the curriculum. For example, when asked what Student D is like as a student, Ms. D opened with a comment regarding her reading abilities, “Uhhhh, she’s struggling because of her reading I think,” and later comments with “The reading really holds her back.”

Development Reading Assessment level, or DRA level, is a standard for measuring, assessing and referencing students’ literacy ability (Pearson Education Inc., 2005). All of the students in this study were well below DRA grade level by 1 to 2 years. Table 3 displays the average DRA levels at the time of interviews, compared to expected grade level.

Table 3

Development Reading Assessment (DRA), 2nd Edition Levels. Grade one level expectations have been included for comparison

	Number of Students	Students’ Average DRA Level at end of Grade	Standard Deviation	Target DRA for end of Grade
Grade 1	0	-	-	16
Grade 2	6	13.3	5.3	28
Grade 3	2	20	0	38

All of the students discussed were struggling with their reading abilities. All eight students struggled with reading comprehension in various severities, while six students, A, C, D, E, F and H, additionally struggled with phonemic decoding. Although these six students have the same difficulty, the specific ways in which they struggled varied. The following transcript excerpts illustrate this.

Ms. D shared,

We've stretched her up to [basically the beginning of] grade 2, and this is the end of grade 3 so she's really two grades behind in reading. Um, and sometimes that's generous. It kind of depends on the day. Sometimes she's you know, more confident and she's taking more risks and she's able to sound out the unfamiliar words a little better, but on an off day there's a lot of trouble with accuracy, and with sounding out even basic words (Ms. D).

Ms. D also added,

When I first listened to her read I noticed a lot of the time she would look at the first few letters and then she would just guess something that started with those first two letters. If it was an *st* word it always happened to be *strong* or *straight*, or *some*, you know, no matter what the word was, it would just automatically go to that word (Ms. D).

When asked about Student E's reading fluency and decoding Ms. E shares the added frustration of the timed DRA assessment,

It's quite slow, well now and now they've changed it, like his level could have been a little bit higher last year, but now they've changed it so we're timing them, and because of that, um, you know if he can't do it in the time given, then you

have to bump him down to the next level lower than that one. Um... so the books he's reading, his fluency is pretty good, but it's only level 10, so you know like he's attending to the periods, you know most of the time in his sentences, and he is using uh, like I said, rereading and self corrections and stuff like that (Ms. E.)

Ms. F describes how Student F is struggling to use basic reading strategies that have been taught,

It's the sounds [that cause him to struggle]... yeah, decoding, and the sounds, and he'll basically, he does the right things like look at the pictures for cues, but he'll look more at the pictures than um, look at the actual words (Ms. F).

Student H is able to use most of the strategies he's been taught to decode words effectively, but he has developed few sight words. He also has difficulties tracking words on the page. Ms. H referred to these characteristics throughout the interview,

He does do some re-reading if it doesn't make sense. So if he's able to read most of the words he'll go back and fix up... uh, he does stick with it, like he doesn't give up easy. He will sit there, he'll sometimes sit there for quite a while trying to figure out the same word, and you can hear him, he talks out loud when he's sounding it out, each sound and sort of talking it though which is good (Ms. H).

She later also shared,

He has difficulty making connections, he'll make some, but most often not... uh... he has great reading strategies to help him solve words, with the exception of the Chunky Monkey which is the blending, and um..... and chunking, blending, often there's not predictions, and he rereads his work... not his work, he rereads his text if it doesn't make sense and he's stuck (Ms. H).

Regardless of students' phonological awareness and decoding abilities, all of the students struggled with reading comprehension. Again, their abilities varied.

After focusing in grade 1 on phonemic decoding, Student B has become quite successful at reading fluently but she is having a very difficult time understanding. Ms. B referenced Student B's struggle to comprehend several times, which suggests it is a prominent issue in Student B's ability to learn. Ms. B explained, "When she sees the print visually she can comprehend a little bit", and later shared, "If we do a read aloud and you ask her anything about that, she has no information or it's, like I'm sure when she does a retell that it's some other story she's retelling". Student B's phonetic decoding skills are so strong, that she can read almost any word she comes across in texts, but according to Ms. B she understands little to no information she's read. Ms. B elaborated on Student B's comprehension several times,

She is good at decoding, and where she breaks down is in understanding and now that the books are getting too... have more of a story to them, it's becoming a little bit more difficult for her to understand and to do well on the computer tasks that we have (Ms. B).

If... the average student, if there's a word they don't know they'll say, "Well what does this mean?" you know, it's hindering their comprehension, where as she'll read all of them, but not understand anything, but there wouldn't be, like she couldn't self assess and say, "Hmmm.... it's this word here that's causing the problem." As far as she's concerned it's, "I read it, and I'm good to go!" you know, especially when it comes to nonfiction. She'll always say, "I'm ready for my test!" (Ms. B).

With Student D, she has a limited ability to comprehend work that she has read herself, but has a better grasp when something is read to her. When asked if Student D's comprehension is better during guided reading Ms. D replied,

It seems to be, yeah. If she's following along um, she, you know, she knows that she needs to follow along with her finger but she's not always able to do that because sometimes she's distracted and things like that, you know. She'll kind of be staring off in space. She doesn't always have her finger pointing in the right place. Um, it seems to be if she can listen and hear the story you know as somebody else is reading it then she's able to put up her hand and answer lots of questions (Ms. D).

Student E also has weak comprehension skills for his grade level. He has a limited ability to display his level of comprehension. Ms. E explained,

With him, trying to get him to do more predictions, and inferencing, and like his connections, like he sometimes, like his text to text, or text to self connections are kind of narrow. Like, he will only talk about certain things, a lot of times when you say you know well, "What does that sort of make you think of, or what connection can you make?" he can't give anything, or or just it's always the same one, it's like you know, "I made money and I went to get candy at the store." It's something that's not really a connection to the book (Ms. E).

Ms. G used a DRA answer sheet to explain Student G's strengths with phonemic skills and how her comprehension ability was lacking,

Right so as far as missed cues or anything like that, there were no, there were no mistakes made, which is strong, you know, and then the new element is timing.

So as far as timing you know she's still strong in that. Where the difficulty comes, and why maybe she's not at a level 24 would be in the comprehension, in the, you know, the, "Tell me what you remember about the story." So... in the recall of information, that's where the check marks indicated what she told me, the circles indicate what I needed to prompt her to remember, you know by giving her, "Well what happened after... or before, " you know, things like that. So again, she's recalling basic information. I mean it's on topic, it's not like you know she's pulling it out from somewhere else, you know, it's still good, but it's not, not an independent level by any means as far as comprehension (Ms. G.)

Regardless of the range of reading abilities these students display, they all have some important characteristic in common. All are behind their same-aged peers, and score at least one grade level behind the standard, and all struggle with the ability to comprehend what they've read. The inability to comprehend what they've read plays into other areas of the curriculum.

Writing

Like reading comprehension, all teachers reported that their students struggled with writing. Students seemed to struggle in two main areas of writing. The first is their ability to spell and the mechanics of writing itself, while the second is in translating their thoughts and ideas into written words on paper.

When asked how their students' writing abilities were, Ms. D and F chose to focus their answers on the students' phonetic abilities and mechanics of writing. Ms. D shared,

I don't know [what's going on with her writing]. She seems to have a lot of ideas, you know and she wants to write them down, but when they're written down it's all.... not necessarily nonsense, but its phonetically spelled... made up spelling for a lot of the words. And if it's spelled correctly up here it might be spelled differently down here and a totally different way down here.... that kind of thing. So there's no consistent pattern following, or rule... you know, that kind of thing (Ms. D).

Ms. F also discussed how Student F is below grade level with his writing ability, "You can, you can read his writing, like it's not messy, but um... he doesn't have the proper spelling techniques yet. He reverses, like there's a lot of letter reversals." Ms. E touched on Student E's spelling as well. She described how he often comes close to spelling words correctly. For example he will spell the word dinner, *d-i-n-r* demonstrating that he understands spelling concepts however his understanding is not at grade level.

Ms. E, along with Ms. B, C, H and G, mostly focused on describing the content of their students' writing. In general, writing samples from these students were superficial and basic, and students lacked the ability to demonstrate examples of higher level thinking. Ms. B described how her student failed to understand concepts behind quality writing; rather Student B will simply write the same sentences in different ways. Ms. B explained,

And, well I don't know like if she'll say, you know, um... "I love grandma. My grandma loves me. I love my grandma and she loves me too. I love my grand..." and how, okay! Why? What does grandma do? You know, what do you do that,

you know? And even then, with all the prompting to get something, she still doesn't understand type thing so.... (Ms. B).

Ms. B also explained how Student B struggles with procedural writing,

When I did procedural writing we were doing brushing your teeth, and it was an assessment task, so I... I can't help her with it, but with a lot of the kids we said, you know, "Pretend you're actually doing it, what are the steps". She could not do that at all" (Ms. B).

Ms. E also used the example procedural writing to explain how Student E struggles with writing. When discussing how Student E wrote the steps of a magic trick Ms. E explained,

He didn't explain it well enough. I said, so I had him read it to me, and I did exactly what his steps said, so just to, you know try and give him an "Ah ha!" moment, you know. [He said], "Oh, I didn't really write about that, " you know, things like that, just getting him to be more detailed in his work. And again, that was tricky because, you know, there was a lot of steps to write down... He doesn't add enough uh, you know it's still pretty basic (Ms. E).

Math Characteristics

Similar to reading and writing skills, all interviewed teachers were concerned about their student's math abilities. In discussing their concerns, teachers noted two potential explanations that may explain their students' struggles in math. The first explanation was students' lack of a foundational knowledge base for math concepts, including struggles with remembering previously taught concepts for later use. Second,

some teachers attributed their students' math difficulties to their weak reading and writing skills, and struggle with higher level abstract thinking.

When discussing math characteristics, Ms. A felt that a lack of basic skills is the main reason for Student A's troubles, "She struggles with every part of math. Can't count by 2s, 3s, or 4s, can't identify patterns, does not know basic numbers.... She doesn't know the basics; she didn't get them from JK, SK, or grade 1. It's like her brain turns off and she gets an overall block." Ms. B shared a similar frustration and discussed how taught concepts are almost always lost when revisited, "In math, unless you know they've been recently working on that, and sometimes then, but if it's something they've done a week ago then revisiting, chances are she won't remember having... it'll be like she's never done that before."

Students' forgetting of previously taught, even simple, information acted as a great barrier to their success. Ms. D explained an incident where she was shocked to realize her student struggled to identify and recall the name for a square,

We were figuring out the shapes and she had to name the shape before she could tell me how many faces, edges, and vertices. So, it was a square based pyramid, so I had to show her. She knew it was a pyramid, but she wasn't sure what it was exactly called, so I said, "You look at the base, and what's this called?".... the word just wasn't there. She couldn't come up with the word of what this shape's called. So I put it on, I thought okay, this might be because it's a 3D shape and she's not sure what I'm talking about so I um, took a post-it note and I put it in front of her and asked, "What's this shape, right here?", and I had to tell her what the shape was, and she was like "Oh.... Right right right..." (Ms. D).

Ms. D also felt that Student D would be stronger in math and numeration if her reading was stronger. Ms. G recalled a similar incident where Student G had forgotten a skill,

It's kind of strange because you know, you think that, you know "Yes! We got this." Like money for example. We, we started our unit off and we're brainstorming what they already knew about money and she was putting her hand up saying, you know "A quarter is 25 cents", and, and I do recall when we were doing this, she made these comments like, "Oh my dad was telling me this." So again, there's that parental involvement, and what what happens outside of school she's able to bring in, and then it was, I don't know, a day later? A couple days later? And we were doing another activity and it's like, "What's a quarter worth?", "I don't know..." " and so, you know that was something that has really stuck out in my mind is that, the the disconnect, the idea that one day it's good, the next day I don't know what happened to it (Ms. D).

Ms. C also mentioned how Student C struggled with the basics of math; however she felt that most of his difficulties stem from the reading and writing components of the subject. Ms. C's focus was on a kinesthetic math program, but when she was delivering a traditional pencil and paper lesson she found Student C struggled, "So, um, when I did [give tests] Student C really struggled with the concepts. Sometimes it's because he couldn't read the instructions, other times it was because that, that, method of giving information is... was overwhelming for him. It was a lot of writing". Similarly, Student H has significant trouble with both retention of material, reading questions or word problems, and giving written answers. Interestingly Ms. H also mentioned that Student H

has trouble tracking questions on his page, and needs help focusing on the question he is working on.

Discussions with Ms. H, B, D, and F had comments suggesting that their students had difficulties with higher level thinking. For example, Ms. D commented that she is unsure if Student D's understanding of math concepts will ever reach a sophisticated level, and Student F has been placed on a modified math program to accommodate his inability to comprehend grade level math.

Attention and Memory Characteristics

Overall the attention and memory characteristics of the students stood out from what teachers would expect from typical grade level students; however specific details shared by teachers varied. Ms. A, B, C, D, E, F, G and H all felt that their students regularly lacked the appropriate attention during lessons and seat work. This lack of attention looked different for each student. For example, comments from Ms. A, B, D, E, F and J mentioned that their students regularly needed prompting to stay attentive as they were easily distracted away from any classroom activity. Ms. E discussed that Student E can't sit still, and regularly needs redirecting back to lessons and activities. She shared,

Well, if I have him retell things that happen in the story, he could tell you some of that, but like I say, he doesn't focus the whole time so he's just... like even sitting, I could talk to him ten times in five minutes about, you know face forward, criss-cross, you know just to get him to look like he's attending (Ms. E).

Ms. A shared similar thoughts about her student and suggests the possibility of Student A having attention deficit disorder. Ms. B, E, F and J attributed the lack of attention to students' inability to understand oral information, or comprehend lessons.

Students C and G were similar in that they could focus at times, but were less likely to focus when given seat work. Their teachers felt that they often became distracted by social or non-academic events in the room. Interestingly, Ms. H had unique attentional characteristics for Student H. While Student H often had difficulty attending to lessons or seat work, he also had difficulty with visual-spatial attention. Ms. H discussed how he had trouble focusing on the proper page on his math worksheet, or following along in books. This characteristic was unique to Student H.

Overall, the students' memory can be described as inconsistent. In general, sometimes the students could remember material, concepts, terms or other components of lessons but often forgot when the material was revisited at a later time. Teachers often used math as an example when describing how students forgot concepts (for example, the quote from Ms. D in the Math Characteristics section regarding forgetting the name for a square). Ms. B shared, "In math, unless you know they've been recently working on that, and sometimes then, but if it's something they've done a week ago then revisiting, chances are she won't remember having it'll be like she's never done that before." (Ms. B). Ms. C described how Student C had an excellent memory for social events or oral information but not for academic facts,

You know it's frightening. He doesn't forget. Like, if you make a promise, he won't forget it. So, you know, "Oh [Ms. C], we didn't get to read aloud today! You said we were going to do it at 10:30!" Or whatever, 11, quarter after 11.

“Okay [Student C], we’ll do it tomorrow.” You bet your life he would come in the next morning and say “[Ms. C], put read aloud on the board, you said we could do it.” So he would remember promises you’d make to him, but again those fast facts, 5+5, um, 6+4, like those partners of 10, doubles, 6+6... no memory for that kind of thing. (Ms. C)

Ms. C suggested that Student C remembers oral information that has more concrete meaning to him,

More academic stuff yeah, [he has more difficulty remembering]. Although, again, if you asked him to recall something from a text we’d read in, at the beginning of the year, he can tell you what the moral of the story Rainbow Fish was. He could tell you that, and again that was orally communicated. (Ms. C).

Ms. G suggested that items that are not revisited are more difficult for Student G, and relates this to language and math. Reading and writing are practiced on a daily basis, whereas math is done every day but each unit is quite different.

Part 2: Adaptations made by the Teacher

The teachers took notice that their students were behind classmates. In response to their growing concern for their students’ progress, the teachers employed several strategies to help students with working memory impairments with classroom work. While teachers felt that the strategies were effective in assisting the students, strategies did not completely resolve academic struggles.

Below are descriptions of the strategies teachers used to help their student with working memory impairments. The strategies were used for a variety of learning

objectives in reading, writing, math, attention and memory. At least two teachers described each learning strategy as useful, with most strategies being discussed by five or more teachers. Thirteen strategies are discussed in total.

1) One on One Support

This strategy was used by teachers when they had time, or an opportunity to work with the student in a one to one manner. It allows for direct, explicit teaching to specific areas of students' needs, as well as an opportunity for instant feedback and prompting. For example, Ms. D explains how Student D experiences success when having one on one support,

I'd say it... if she has somebody you know watching over, and you know pointing things out then she'll definitely make fewer errors. Like when she does it at home her mom is supervising and, and she makes fewer errors there, but if she's left to her own devices, there's a huge difference between when she's beside somebody and someone's reminding her and prompting her you know, "Stay on the line, think about what you're doing, take your time" that kind of thing. And focusing her on, you know, the presentation kind of idea, and organizing it logically... um... with her math and her writing, if there's somebody there to remind her she does much better than if she's just left to do it on her own (Ms. D).

Each teacher interviewed expressed that this was a significant part of the strategies they used with the student in question. When time constraints limited the amount of time teachers had to work one on one with their students, they often had volunteers work one on one by reading, or assisting with classroom work.

One reason this strategy was so significant for teachers was because of the recognized need for intense support for the student with working memory impairment. Ms. B shared, “We try to have one on one help with her every day as well. So she’s someone in the class that we have uh... decided would benefit, so every day she has 15 minutes of one on one help.” (Ms. B)

Two of the students in particular loved the one to one attention, making this strategy a positive experience. Teachers felt this increased its effectiveness. When discussing what advice she’d pass on to next year’s teacher she explains, “[Do] anything one on one because he so... seeks that approval that one on one with him was very effective. So, all the work we did with the ummm, with the uh... volunteers and all the conferencing that we did was very beneficial for him definitely.” (Ms. C). Similarly Ms. G explained how Student G also responds positively to this attention,

She loves adult attention... she loves one on one. Uh, she’s in her glory when uh when she goes [to see the learning support teacher (LST)], so it’s never, never a problem. Ummmmmm, and yeah, she does you know she does as far as the LST that has reported to me, you know she works really hard when she’s there. Never an issue with that, so....” (Ms. G)

Ms. F found using a one on one strategy to be the only truly effective strategy when working with Student F. She expressed how he needed constant support to get almost any academic work done. She used the support of an educational assistant to work with Student F in a one to one or small group manner.

Overall, while the one to one strategy was employed in slightly differing ways by teachers, all expressed it as an important strategy used to help their student. Each teacher recommended it when teaching a student with similar learning difficulties.

2) Building from the Basics

Building from the basics includes the revisiting of material from earlier grades prior to moving forward with grade level curriculum. This strategy arose when discussing literacy and math. Five teachers expressed building from the basics as being a strategy that was critical when introducing new concepts.

When discussing reading, teachers explained how important it was to revisit basic phonics and sight words in order to read and understand texts. Ms. A explained how she had a lower level class and revisited these concepts for the entire class. She noticed that this was to Student A's advantage and it really helped Student A tackle books at her reading level. Ms. B described the long-term plan they had for Student B to help her develop basic knowledge, "Well she started with, you know letters and sounds, then she went to sight words, and when she knew her... you know a certain level of sight words we started with reading at her level... and with the earlier books she made a lot of success with that" (Ms. B). Ms. B also explained how she will spend time to build vocabulary prior to lessons to help with her understanding,

Whatever we're working on, she has to have that base vocabulary built in for her whether... because another part of daily five of course is the guided groups. So in guided groups you know she has to have some time to make sure she has that, built that understanding of vocabulary (Ms. B).

Ms. G also had success with putting Student G in a lower level program to revisit skills,

As far as our phonics program, we, in our classroom we do phonics books and we work through them at a progressive rate... she.... We did put her in a year earlier, or a year behind what the rest of [her class] was doing. So although that was maybe not welcomed, or maybe not seen as something good from her parents, and from others, in the end its its worked out well because she she needs, she needed that, the review of the basic phonic skills in order to build upon what... what uh... what she needs to do (Ms. G).

In terms of the math curriculum, where there are several unrelated units visited once per year that build on material from the previous grade, teachers especially noticed that time needed to be spent revisiting prior concepts. For example, Ms. A discussed how it was difficult to teach many math lessons to Student A because she has lacked the basic numeracy knowledge. She provided examples of counting, understanding quantities, addition, and subtraction. Similarly, Ms. B explained how Student B needed to re-understand the basics before she could complete math tasks, "If she had some base in that, that, like if she knew how to count blocks for example when we were first doing addition, then once she understood that she could continue on." (Ms. B). Ms. G suggested that perhaps there is a greater need to re-teach math skills because the separate skills are not visited every day like they are in reading and writing. She wishes she could somehow implement a program where different types of math questions would get revisited on a weekly basis to help to students' retention.

The lack of remembering basic knowledge and skills posed a serious issue when teachers tried to deliver grade level curriculum to their students. Building from the basics was therefore a necessary strategy for some, prior to continuing with grade level material.

3) Extra Practice and Repetition

The participating teachers noticed that their students had a difficult time grasping, and remembering knowledge and concepts. In response to this, six of the teachers recommended and/or employed extra reading, writing, and math practice. For example, Ms. H often offers extra practice in a one on one setting where she reviews sequencing stories, beginning, middle and end sounds of words, and other foci. She's found some success with the extra practice, particularly when it comes to rereading texts, "Just the continued, like repetition of getting him to reread books that he's read... That's been good and he's successful with that because there's a familiarity to it" (Ms. H)

Many of the teachers suggested that some of this extra practice would have to be occurring at home or in after school programs. Ms. D shared, "Sending her to extra reading practice, and encouraging her to, just like all the other kids, read every day... and um.. uh, she has been given certain things she can do at home, um, to do extra reading practice" (Ms. D). Alternatively, Ms. E had hoped Student E could have enrolled in an after school club where academic skills were reinforced,

We have a booster club after school. It's Monday and Wednesday for grades 1, 2, and 3, and really wished he'd gone in that because they do Destination Reading, and they do all sorts of programs. It's sort of like a tutoring program after school. It's not like a homework club, cause we had a homework club too, you know a lot

of my kids were in that... but you know he would have benefitted from being in that (Ms. E).

Ms. B, D, G and F found that their students were particularly competent with the computer and used computer programs or websites for extra practice opportunities. Ms. B felt that the computer was an excellent learning tool for Student B. It was also one of her strengths,

She likes working on the computers, and that's where she's almost like the furthest one in the class on Essential Skills. So, she really likes that and I think it's a combination of the visual and the oral, or ya.. the visual and oral together and... just the practice, practice, practice. So, she likes that, of course. (Ms. B)

Similarly, the computer is a strength for Student D, and F as well.

Ms. A and B feel that extra practice and repeating skills is an essential part, and the reality of how learning will always be for their students. Ms. B shared, "It's repeat, repeat, repeat for her. Definitely not going to be, we've looked at it once and we're going to understand it" (Ms. B).

4) Prompting

Prompting was another strategy that was employed by all teachers interviewed. Prompting is used to draw students' attention to instruction or specific components of a task, or to direct students' thinking. How prompting was used varied between students, teachers and settings. Often it was used to bring students back to focusing on a task at hand when they were working on something independently. Other times it was used during large or small group instruction to help students narrow their thinking to produce

answers. Often, Ms. H even used prompting to focus Student H's visual attention to specific parts of a page.

One of the main ways in which teachers used prompting was to bring students' focus and attention back to the task at hand. Ms. A felt that it was a constant struggle to remind Student A to focus on her work and worried that her inability to focus may be related to Attention Deficit and Hyperactivity Disorder (ADHD). Although Ms. A was the only teacher to connect her student's attention difficulties to ADHD, other teachers experienced similar issues around focusing and had to constantly prompt students to stay focused. Included in this group were Student B, C, D, E, F, and G. For example, Ms. E shared, "He can't sit still very long and he has a very short attention span, so you're always trying to draw him into the activity, redirecting him," and later mentioned, "I just find he's better when he's uh, even when he's in the small group you have someone directing him, you know just getting him back on task with things" (Ms. E).

A second way in which teachers used prompting as a strategy was to help students narrow their thinking to retrieve information and answer questions. This was used in large, class activities or in small group and one on one sessions. For example, Ms. H shared an example of how she would use prompting at the carpet to focus Student H's attention and prepare him to answer a question,

I'll be like, "Oh yeah, [Student H] you're doing the next one" and I sometimes will tell him before, so that he sees someone do it first... because if I just call on him, like I never want them to feel centered out and uncomfortable, so I'll tell him ahead of time.. "You're going to be doing the next one. Be thinking about..." or you know, "Watch so and so, they're going to do one now" (Ms. H).

Ms. H felt this form of prompting helped her student narrow his thinking to come up with an appropriate answer. She would also use prompting questions to help Student H retrieve information or develop ideas when completing writing activities. She provides starter sentences to prompt students to create answers that are on track. For example, Ms. H will ask simple, small questions that will lead Student H to the bigger answer. She will then help him create the larger answer by starting it for him or summarizing his ideas from the smaller questions. Additionally, prompting in a small group or one on one session can prevent students from making mistakes, and allow them to complete tasks accurately. As mentioned in the *One on One* section, prompting helps prevent Student D from making mistakes and also helps her think through the steps required to complete her work.

Interestingly, Ms. H mentioned how she will often use nonverbal forms of prompting to focus Student H's visual attention, particularly during math activities. She explains,

I'm doing.... a combination I would say, like I'm doing a lot of... well you can group it as one, but I do sort of like signalling him right... so the verbal... and so auditory I guess, and then um... I will point to... like, whether like he's looking on... I'll direct where he's looking right, so I'm I'm kind of focusing him wherever my pen is, or wherever my finger is... otherwise he'll kind of just... and he's cooperative, but um... just like getting him to focus on that... or sometimes I'll cover up some of it, so if we're doing addition at the top and subtraction at the bottom, I don't want him to get confused with that so I'll just sort of take a paper and cover the bottom half. (Ms. H)

Ms. H felt that prompting in this way reduces the amount of verbal cueing required to keep Student H on task, and overall helps him be more successful with his work.

While prompting was used in different ways by each teacher, all felt that it was an important strategy to be used with their students with working memory impairments.

5) *Chunking of Information*

Chunking of information refers to when teachers break down instruction or information into smaller pieces such that information is given in parts rather than as a whole. It may include giving instructions in a single step fashion and waiting for a student to complete each step prior to giving the next direction, or providing information in a simplified, grouped format. Four of the interviewed teachers noted that chunking information or directions was a strategy used regularly to teach their students with working memory impairments.

Ms. B discussed how she needs to give Student B short instructions, one at a time. She also shared how having a student like Student B has made her conscious of how she delivers instructions to the rest of the class,

That's why I've been working on, trying to be more concise in my instruction time... and so that's really hard because you start talking away, you've got all these words and I think especially with someone like [Student B] you're saying all these words, but that's not really the meat of what you're doing (Ms. B).

Ms. F uses an even more simplified version of chunking instruction. She uses a “First _____, then _____” approach to help keep Student F focused on the task at hand. She also mentioned how Student F requires a reward system to help focus him. Ms. F chunks visual information as well,

I think things for him need to be broken down, and like chunked out always... like everything needs to be chunked. If you're going to be reading something, chunk out those lines for him... So chunking it would definitely be a strategy for him. You just have to literally simplify things for him (Ms. F).

Ms. E and G also mentioned chunking of information as a strategy they used with their students. Overall, teachers felt that delivering information and instruction in this manner helped keep the students on task and assisted their understanding.

6) *Check for Understanding*

Checking for understanding refers to teachers following up with students after a lesson, and prior to starting work. The purpose is to ensure that students understood the lesson and knows how to start the task assigned. Five teachers used this as a regular routine in their classroom for helping their student with a working memory impairment. Ms. E implemented this strategy in various and effective ways. For example, she will often have Student E restate the instructions or steps of a task back to her (the teacher), once the rest of the class has been sent to work,

A lot of times I'll get him to do some self-talk, you know explain it back, you know, just talk to yourself and talk out loud as to what you have to do, and sometimes I just have him give it back to me as well just so I know he knows

what to do instead of always hearing it from someone else. I just find that because of his attention span it helps (Ms. E).

Ms. E uses this strategy to help Student E understand instructions, and as well as to assess his comprehension for her own knowing,

Well I just want to know if he's even listened well enough to even understand what he's supposed to be doing right? So, yeah, and then if he has a question, I just want to see what he remembers about what he's supposed to do, but he's quite distracted at, you know, tasks too... so..." (Ms. E).

Similarly, Ms. G recommends to any future teacher to check in with Student G frequently, as the student will often pretend to be on track. She shared,

Always, always check in with her, cause she's she's developed you know, some amazing strategies with copying from others, with what it looks like is you know working. She looks like she's working but in reality she's not, and and it's not until afterwards you look at her work and it's like, "Oh my gosh! You you didn't catch that instruction, or you didn't get it" kind of thing.... You know, just the yeah...keep her close. (Ms. G)

The other teachers agreed with Ms. G; it is very important to keep a close eye on the students with working memory impairments to ensure that they understand their work.

7) Student-Teacher Conferencing

Student-teacher conferencing is a strategy that combines one on one support and checking for understanding. It occurs when teachers take time to speak to their student

one on one to discuss a particular learning assignment or area of need. The conference often includes a discussion of strengths and needs of the student, and teachers will often provide next steps or ‘bump it up’ strategies for improving work (e.g., small changes a student can make to improve their work, such as add detail, use a synonym, etc.). Conferences could also be used as an informal assessment tool, or an individual teaching opportunity.

Ms. C felt conferencing was a very useful teaching strategy to use with Student C as it gave Ms. C the opportunity to direct Student C for success. Ms. C wished she had used conferencing as a more regular weekly routine with Student C since it was so effective when she did meet with him in a conference style. She shared, “[If I taught him again next year] I think I probably would have um, taken the time to set up a permanent meeting with Student C. Um, every Wednesday or something to have him, um, discuss one particular reading strategy, or, um, one particular writing strategy” (Ms. C).

Ms. E most often used this teaching strategy to help Student E assess his own work and guides him on how to ‘bump it up’, or make it better. She also used it as a form of informal assessment, “I conference with him a lot, you know, to see what he’s getting out of his math, or if they’re writing or reading, um, more so than others because he’s you know a lot lower than others” (Ms. E).

Overall, there were three teachers who identified conferencing as a useful strategy that helped them understand their students, and allowed them to individualize their teaching.

8) Minimize Distractions

Five of the teachers mentioned how important it was to minimize any distractions that may prevent their student from listening, or staying on task. Teachers implemented this strategy in a variety of ways. For example, some of the students have their desk moved apart, or students are moved to a quiet corner in the room. This helped the students stay on task while doing seat work. There were many other distractions that teachers mentioned they needed to be proactive in reducing. These included small group placement with specific classmates, making sure their student had all the proper tools (pencil, eraser, glasses), tending to social problems that might distract the student in the classroom, strategically assigning seats, and others.

Ms. E discussed how rather than minimize distractions, she used strategies that helped keep Student E focused and on task. One of these strategies included using a timer, “I’ve been using a timer. Sometimes I use timers for tasks, ‘cause it’s kind of fun, but it also helps keep him focused because he’ll think, “Okay! I gotta get this done before that buzzer goes off!” (Ms. E). In a similar way, Ms. B uses routines in her classroom. Routines help by consistently reinforcing expectations, and therefore helped Student B stay focused during transitions or seat work. Student B then has less information to take in, interpret and act on. Teachers found that using a variety of strategies to minimize distractions or keep focused helped their students with working memory impairment, particularly when attention was a concern.

9) *Teaching Students to Use Tools*

Another way teachers hoped to help their students was to provide tools to assist with work. Five teachers mentioned specific tools they used, including word walls, math walls, dictionaries, anchor charts (charts on walls that provide information), calculators, math manipulatives, and reading strips to help students track words. Teachers provided these tools for use by all their students but found that they particularly helped their student with a working memory impairment. While some students were able to use the tools independently, others were still working towards independence. Ms. A recognized that developing the maturity to work and use these tools independently was one of the next steps in helping Student A academically.

Some students required tools to help with visuospatial information. Ms D, E and H gave reading strips or pointer tools to help their students focus their vision while reading. Reading strips help by focusing students on the correct words and follow along through a page in the correct sequence. Ms. H also used a similar strategy during math. She would often use blank sheets to block out parts of a worksheet to help Student H focus on the correct portion of what he was working on.

Teachers hoped that students would think to use these tools on their own, but many of the students were not yet at the independent stage and still needed prompting to use them. Students who had learned to use tools independently could now use them as a *self-strategy*. This will be discussed in Part 3.

10) Positive Reinforcement and Building Self-Esteem

This section, Positive reinforcement and building self-esteem, includes any strategies teachers used to prevent students from feeling poorly about themselves due to their academic weaknesses. This was a strategy that was thought to be important by 7 of the 8 teachers, even though it did not directly help students to complete tasks. Its purpose was to keep students motivated and maintain positive self-concept as a learner. This strategy was particularly important to Ms. E. She discussed how she will strategically place Student E in groups where his group members will be positive,

I think the biggest thing is the social stuff. I have to strategically place him in a group, or somehow work it out that way when he's doing anything, even with a buddy, one person. I really, you know, I really don't want one person to give him negative feedback, "Oh I don't want to be your partner". You know, I work really hard on that cause to me the kids' self-esteem is the most important thing in the classroom that I work on." (Ms. E)

She has also seen improvements in his academic work resulting from positive feedback and reinforcement,

He really does like to, he really likes to do a good job. Like, when he's writing, he'll like, and when we do 'Bump it up' strategies he'll be like "I really tried to bump that up because I put a juicy word in there", or, "I put a bossy verb". And he's really understanding that, and like we're trying to do a lot of descriptive feedback activities, and and the more praise he gets, the better he seems to handle, you know, his workload. (Ms. E)

Building confidence through making adjustments to the curriculum helped Student G in a different way than Student E. It helped her work independently. Ms. G shared,

At the beginning [of the year] she would seek and need a lot of assistance because she didn't have the confidence to do it on her own. Um, so we adjusted some of the expectation and the curriculum that we were giving to her and that allowed her to gain the independence and gain the confidence. So that has really helped throughout the year and that has made a difference. (Ms. G)

For Student C, positive reinforcement and praise helps with academic work indirectly. Its primary purpose was to improve his behaviour,

Positive reinforcement all the time was like the baseline for [Student C]. Like telling him that when he came in and sat down quietly without interrupting or goofing off, “[Student C], I really love how you came and sat down, you did a great job”. Like constant stream of, of positive reinforcement for every little thing. That was so important for him and it really, it really helped to um... what's the word? Uh, bring about more of that positive behaviour. (Ms. C)

The ways in which this strategy was used varied amongst teachers, as each student had a different need in terms of their self-esteem, and their response to positive reinforcement.

11) Play-based Learning and Making Material Meaningful

While several teachers expressed that their student could attend to lessons better when it concerned something particularly interesting to them, only three teachers went into detail about the success their students had when play-based learning opportunities were provided.

Ms. D, E, F, G, and H each commented on how their students did seem to have more success when the lesson focused on a topic of interest. For example, Student F was described as an artist who loved to draw. Ms. F explained how art was one subject where Student F needed little prompting and refocusing as he was naturally engaged in it. Art is a strength of his, so naturally Ms. F tried to use this strength in other areas. Ms. E discussed how Student E could retain more information when it was something that interested him. She used their *Canada* unit as an example to explain, “I find that the more he’s interested in something, the more that he’ll be able to remember. You know like he can tell me all about Canadian animals and sports, but he might not be able to tell me about capital cities and things like that.” (Ms. E).

Similarly, Ms. C and E also expressed that their students were more successful when material was meaningful to them; however these teachers also used many play-based learning activities in their curriculum delivery. Each teacher thought their students were more successful with this type of learning. In Ms. C’s words, “teaching them to learn something without them knowing that they’re learning it” really worked for Student C “. She used play-based learning to teach the math curriculum. Ms. C shared, “My math program, like I said, was pretty play-based and um, a lot of portraying your understanding in pictures, um, showing me with cubes a pattern, things like that. He was pretty good at that stuff. But paper and pencil... he really struggled”. She also explained how she had recently introduced this type of teaching to her class and how Student C had taken off with it,

He LOVED the math games, and I noticed a big improvement um, in the whole...

I only started doing it later like in the spring, but I did notice an improvement and

an increase in enthusiasm in the whole class uh... and I know that [Student C] in particular really enjoyed that. So that seemed to help him a lot. (Ms. C)

Ms. E has a similar math teaching strategy. She uses play-based games throughout the curriculum and felt that Student E didn't have trouble with the probability unit because it was so concrete and play-based. She explained,

We just finished probability and he didn't really have a problem with that because we were doing a rolling dice game and they had to graph it to see which number won, and a coin toss, and you know, just remembering to the tally marks right away, you know and the spinning activities. Like, he did okay on that, and if he didn't like they were in groups so, you know, we would just pick it up from someone else (Ms. E).

Student E was successful with the activities. He seemed to still have trouble with the pencil and paper task of recording, but he was able to understand the material.

Twenty minutes of daily physical activity, or DPA, is a program mandated by the Ontario Ministry of Education (Ontario Ministry of Education, 2005), and Ms. E will tie active literacy games into her DPA programming,

I do a lot of quality daily physical activity in my room for DPA because I just find that, you know, after 10, 15 minutes, I just find, okay, let's get up and you know, do something on the Smartboard. And there's literacy games where you throw a koosh ball at the Smartboard, and it hits a coloured circle and it tells you to do 10 sit-ups, or say "rowboat" 10 times, and it's just fun stuff you know, to just get them up, get them moving. Um, different activities like that and um, I have this tennis ball, and you throw the tennis balls in the air and it's a scramble, and they

have to find someone to match up the same letter, or match up the same word, and I just have to really do that (Ms. E).

Overall, the teachers felt that play-based learning grabbed their students' attention because it was meaningful and fun. This helped them remember and learn subject material.

12) Modelling

Modelling involves demonstrating techniques and strategies for students to mimic in their own work. While this is a typical group teaching strategy, three of the teachers expressed that it was also a specific strategy they employed for their students with working memory impairments.

Ms. H uses modelling in every part of her classroom to create an enriched environment. She explained how Student H struggled, "Our class is very rich as far as like what I'm trying to offer and so you'd think that he would pick up on something just being... you know what I mean? Like being immersed in the classroom, immersed in balanced literacy" (Ms. H). She explained how Student H responds more positively to her modelling when they are in a one on one or small group setting. She will often model strategies for reading and using math manipulatives repeatedly with him.

Ms. E and G spoke about using stronger students as peer support for their students with working memory impairments. Ms. E referred to peer modelling strategies several times. Here is one example,

We do little placemat activities. It's a Berry Bennet strategy where it's a great big piece of paper and they all have a section to write in, and then they have to uh,

they have to talk about it and then write down the most important things that they come up with in the middle. You know, so there's so many ways that he's getting modelling in the classroom (Ms. E).

Another peer strategy Ms. E used was to have a class expert for particular subjects. These experts helped support struggling students, like Student E. Ms. G uses this strategy as well, "I have what we call Experts, so kids have, you know, completed a task and everything is corrected. They turn around and help others, so um, you know [Student G], she gets through it" (Ms. G).

13) Accommodations and Modifications

Accommodations and modifications refer to changes teachers make in their regular teaching delivery to meet individual learning needs of a student.

Accommodations occur when the teacher uses specialized teaching or assessment strategies that are not provided to typical students, but are required by a student with special learning needs to achieve learning expectations and demonstrate learning (Ontario Ministry of Education, 2004). The child is still expected to work towards grade level curriculum expectations. Many of the strategies a teacher might use to accommodate assignments and seat work for an individual student's needs were mentioned above (one on one support, learning tools, chunking of information, etc.).

Beyond the accommodations to general academic work, teachers also discussed how they often accommodated assessments for their students with working memory impairments. Ms. G accommodated Student G's tests by reducing the amount of questions she has to complete, and making sure that she understands what questions are

asking on assessments. Ms. D will accommodate assessments by reading and/or rewording tests. She will also scribe Student D's answers so that she can be more successful.

In comparison to an accommodation, a modification occurs when the curriculum has been adjusted from the grade level expectations to meet the student's individual learning needs (Ontario Ministry of Education, 2004).

Four of the teachers modified expectations of their student with a working memory impairment. For example, Ms. G modified Student G's programming when she placed her in the phonics program a year below her current grade level, as discussed in the *Building on the Basics* section. Additionally, Ms. G adjusted other curriculum expectations so that Student G could experience success and gain confidence in herself. This was outlined in the *Positive Reinforcement and Building Self-Esteem* section.

Similarly, Student H was given a modified spelling program. Ms. H shared, "As far as his spelling words [he] did rhyme families and everyone else was sort of working on um, like harder words, but he's still working on like the '-at' family or he's still working on, you know those kinds of things". Student D received a similar modification,

So we tried her out with the regular spelling list and it wasn't really going very well. She would do the exercises perfectly fine, but then when it would come to the actual dictation, it was always you know, 5 out of 13 or something like that. So we changed her to um, a basic phonics based kind of spelling list where all of the, you know, they're all word families, words that rhymed with each other...that sort of thing. (Ms. D)

Modifications can occur in the classroom as needed, but only students who have been identified by the school as needing an Individual Education Plan (IEP), can be evaluated for the report card through modified expectations (Ontario Ministry of Education, 2004). In other words, only students with the written IEP document may be evaluated on a report card through curriculum expectations that differ from their grade level.

Student F had been newly placed on an IEP by the school's designation just prior to his teacher's interview for this study. Ms. F had already been modifying his work to the prior grade's expectations since he could not complete work at his grade level, but the IEP allows her to evaluate him based on the lower grade's expectations. Ms. F shared,

Actually after the February report cards, that's when they noticed, "Hey, something needs to be in place for this kid." Like he's not getting the concepts, like the pro-program... like the grade 1 curriculum. So everything's been modified, every subject has been modified for him.... All the writing and reading subjects. So math, science, social studies, and um language arts. (Ms. F)

Other teachers had expressed that their student with a working memory impairment was on a 'wait and watch' list. This means that the school identifies the child as potentially needing an IEP, but they will give time to see if the child improves with accommodations, and time. Additionally the assessment measures used for the identification process are more reliable as children age (Cohen, 1959). Schools will often wait until students enter grade four to administer standardized assessments. Student D is one of these students, and was scheduled to see a psychometrist early in the following school year.

Summary

Overall, teachers employed a combination of the strategies described above in response to their concern for their students with working memory impairments. The teachers were aware that these students were not progressing at the same rate as peers and were falling behind their classmates. They adapted their teaching to meet individual needs of the students with working memory impairments. Not one specific strategy was able to mask students' impairment, nor did one strategy alone help the student.

Ms B explained, "There's not any one strategy that's you know, that she's going to take and just sail with but uh.. [we're] just trying to figure out what's next" , while Ms. D predicted "Maybe [her difficulties are] something that's, that needs to be worked around rather than fixed, because there might not be any way of fixing it. That kind of thing..." (Ms. D). These quotes summarize the essence of what can be taken from each interview.

Part 3: Adaptations Made by the Student

Several of the teachers interviewed mentioned that their students were aware that they struggled academically when compared to peers. Teachers described two types of self-strategies that students used. The first type is strategies that teachers had taught the students. It includes the use of reading strategies and tools. The second type occurred when students were self-aware of their weaknesses and had, in some instances, developed their own self strategies to cope with academic demands.

Learned Strategies

Many of the self-strategies students used were taught to them by their teachers. These strategies included reading strategies and using tools or manipulatives.

Student E and H have been successfully able to independently use some of the reading strategies that they had been taught. Ms. E discussed how Student E will often use picture walks of a book to gather background information and to help comprehension before he reads. He will also self-correct if he makes a mistake while reading by re-reading a section or sounding out words.

Student H also uses rereading as a strategy to correct his mistakes. Ms. H reported that he approached reading with a positive attitude and did not give up easily. He also regularly used the strategies that the class had been taught. Ms. H shared,

He will stick to it. So if he's trying to figure out a word he doesn't easily give up, even if he hasn't... even if he doesn't and when he's sounding out I think he's never going to get it, he still will do it, or he'll skip it and go on. Like he's he's good at he often will use Stretchy Snake, he often will use Eagle Eye we call it so it's just looking at the pictures. Skip the Frog, so he'll skip over it and comes back but finishes reading the sentence and comes back and thinks about what makes sense there or guesses. Um, but the hard one for him is Chunky Monkey and getting it into chunks and remember, "Okay i-n-g is -ing". (Ms. H)

Other students were able to use tools and manipulatives independently to help them complete their work. The tools are those discussed in the section *Providing Students with Tools* and include word walls, math walls, dictionaries, anchor charts (charts on walls that provide information), calculators, and math manipulatives. Students B, C, D,

and E were all able to independently identify that they needed one of the tools and successfully use it to help them complete their work. Ms. B shares,

Now, she can use a tool, you know so I guess that's one thing that's you know like whether it's the math wall, or the word wall, or... and saying well these are things, tools to help you, you know if you can't add, you need to know how to use a calculator, in spelling you need to know how to use a dictionary, and teaching her how to use tools like that....but it's a slow process. (Ms. B)

Ms. D also discussed how Student D can use tools around the classroom,

When she does need words, you know everybody is encouraged to come and see me for their words if they need them. Um, and she knows how to use a dictionary, um and she's pretty savvy with the computer, you know, being able to problem solve and use her strategies, and she can look up things on the computer and things like that (Ms. D).

The other teachers discussed similar observations. Teachers discussed that developing strategies students could use on their own was important to the success of their students with working memory impairments.

Student-Developed Strategies

Three students had a particular awareness that they were academically behind their peers. In response to this, they had developed their own strategies for coping with their weaknesses. These students were C, D, and G.

For example, Ms. D explained how Student D and her classmates recognize that she is one of the lower students in the class. When Student D couldn't recall the name for

a square, Ms. D could tell she was uneasy. Ms. D explains, “I was trying to make it you know as non-issue as possible to make sure you know she wasn’t getting anxious about it, that kind of thing, and um, but you could tell she was, you know, “Why can’t I? I don’t know... Why can’t I remember this?”. Additionally, Student D’s brother in senior kindergarten (SK) is now able to read at the same level as Student D and is even surpassing her abilities in some areas. Ms. D shares,

That was the big, you know, bell ringing thing for her mom in September. Her brother who’s going into SK, now he’s at the end of SK, he’s able to do things better than she can now. And now [Student D] is realizing it, you know, that was at the beginning of grade ___ and now she is figuring things out, you know. That he could read things better than she could (Ms. D).

As a result of this realization of her struggle, Student D has developed some self-strategies that center on using her peers as support.

I think she hides [when she doesn’t get things] pretty well. She’s got all these you know coping strategies I mean she’ll ask her neighbour, that kind of thing. People will, when she’s reading, um, when we’re you know in a group on the carpet and she’s volunteered to read or whatever, if she’s volunteering to read whatever, people will whisper the word to her, you know under their breath (Ms. D).

Student D also pairs herself with students who are stronger than her academically. Ms. D shared how Student D relies on three close friends,

The other girls are quite strong readers and writers, and yeah so she tends to kind of rely on them a little bit, but not sitting right near her or next to her or anything in the class, but she gravitates towards them. Like, if they’re given groups to

chose, you know there's usually at least one of those girls in her group. She doesn't she doesn't seem to be the leader; you know that kind of thing, but the girls kind of look after her. Put it that way (Ms. D).

Similar to Student D, Student G has learned to rely on others for support. Ms. G shared that one of her particular strengths is copying, "She's an excellent um.. copier... just so you know. So she can be here, and someone's over there and she can read upside down. I've been amazed with what she can do" (Ms. G).

Student G has also mastered how to look productive at her desk. She is able to pretend she is doing her seat work such that the teacher thinks she is working successfully on task. When discussing advice she would offer next year's teacher Ms G shared,

Always, always check in with her, cause she's she's developed you know, some amazing strategies with copying from others, with what it looks like is you know working. She looks like she's working but in reality she's not, and and its not until afterwards you look at her work and its like "Oh my gosh... you you didn't catch that instruction, or you didn't get it" kind of thing.

Ms. C noticed that Student C was particularly aware that he was behind his peers and he had developed strategies that were unique to him. Ms. C was impressed with his ability to adapt to hide his weaknesses and spent a considerable portion of the interview discussing his self-strategies. One of her initial comments when describing what it is like to have Student C in her class was,

He also has developed incredible coping skills cause he is weak as a reader, and he's weak um, in numeration. So, he developed incredible coping skills. He could

take things in, use classroom cues like I've never seen before. He was able to um, like, and it's not even like just copy off what someone else is saying, it wasn't even like that - it was just using anchor charts, resources, word wall, things like that so that his weaknesses wouldn't show. (Ms. C).

She also discussed how he was aware that he needed these strategies to keep up with his classmates and hide his weaknesses. Student C was very concerned about how he was perceived by his peers and wanted to hide that he was academically behind. For example, he would frequently choose books above his reading level for silent reading so it looked as though he could read at a higher level. He also used classroom resources to his advantage. Ms. C shared,

He had to [use classroom resources to his advantage]. And he knew that if he didn't, he would look ... quote-unquote stupid or he would look you know, he would look low, he would look like a low reader ...um ... And it took I would say, probably say, six months before he would read out something from a shared reading piece, or something for the class. Um... but he did build confidence as the year went on and he did show improvement, um... but not as much as I had hoped (Ms. C).

Beyond using classroom resources, strategies Student C used were his receptive language and observational skills, neat handwriting and organization. Ms. C described how Student C is observant and attentive to her actions,

He listens like to EVERY word that you say. He's very in tune with all of the teacher's actions. He can anticipate um using cues like, uh, he would know if I photocopied something and put them by the science duo tongs he would say "Oh,

so we're learning about that next period?" He would, he would, really to the point where he was like in my personal space cause he would use like my behaviours, like my teacher behaviours to sort of estimate or, or, or guess or predict what was going to happen, um, so he could be ready. He also likes to sort of be the one that's in the know. So, but that actually benefits him in the classroom. I think it annoys the other students at sometimes but um, and it does get a bit frustrating cause he does get a bit comfortable with you and he gets a bit familiar and you have to, you know you have to build up that wall and make the, make the boundary really clear between teacher and I'm not your friend, I'm your teacher (Ms. C).

She later mentioned how Student C's writing is at a basic level, but looks like it may be at a higher level because of his neat handwriting,

His writing would be very, VERY, superficial. Wouldn't use a lot of descriptive words, a lot of juicy words we call them. Um, basic vocabulary, stuff like that.

His handwriting, again, one of those coping skills, so neat and tidy. He can copy notes from the board so fast, and so neatly because then when he hands in his work, it's perfection. It's not his own work, but its perfection at first glance.

Yeah. Like if he, he, like I said, copying notes off the board, um for science, or um... not that you do that a lot in grade 2 but, any time we were doing a fill in the blank thing his handwriting's impeccable (Ms. C).

Finally, organization is a self-strategy Ms. C has observed Student C using, "He keeps his desk neat and tidy, very organized, knows where everything is all the time, like

doesn't want it messed up because if he lets that slide then something else might show. You know what I mean?" (Ms. C).

Overall, the teachers were impressed by their students' ability to adapt in order to cope with their weaknesses as students. Ms. C was amazed with what Student C could do to compensate for his weaknesses and offered a possible explanation. She shared, "It's almost like its compensating, like uh... uh... a person who is visually impaired can hear 10 times better than a person who's not. It's almost like he's built up these other skills to to compensate for what's missing. It's incredible" (Ms. C).

Discussion

This study investigated teaching strategies for children with working memory impairments by interviewing primary teachers using a qualitative, grounded theory approach. Three main themes emerged when discussing teaching students with working memory impairments and age appropriate nonverbal intelligence. The emergent themes include the characteristics of students with working memory impairments, the adaptations teachers made to their teaching in response to students with working memory impairments falling behind peers, and the self-strategies students used to cope with their weaknesses.

Characteristics of Students

Teachers were each asked what it was like to have their student with a working memory impairment in their class. Each teacher spoke in depth about the academic characteristics of her student, with the majority of the children being reported as falling behind academically in language, reading, and math. Some teachers also added descriptions of the student's social and behaviour characteristics, as well as comments about the family's general attitudes for learning. In particular, teachers described some of the children as having difficulty following and retaining classroom directions, forming a coherent and succinct oral description of an event, and remembering or connecting with previously learned material. Attention and memory were commonly reported as difficult for these children. Given these difficulties, some of the children were reported to have difficulty forming friendships, and maintaining appropriate classroom behaviour.

While a description of students' learning characteristics was not an original part of the research question, teachers discussed their students' characteristics for a significant part of interviews. This was likely because they felt understanding the student was crucial to understanding the teaching strategies they used and why or how these strategies were successful. They often also felt that their students' difficulties were particularly challenging to overcome since these difficulties impacted learning across the curriculum.

Overall, the similarities and differences in the characteristics of students with working memory impairments are consistent with the current literature (Alloway, 2011; Kaufman, 2010; Dehn, 2008). The present study found similarities in the students' academic profile. That is, these students were struggling with grade level curriculum for reading, writing, and math.

Interestingly, some of the teachers descriptions of the difficulties experienced by these students were consistent with a working memory impairment. For example, several teachers reported that the student often forgot steps of instructions, which may represent a failure to hold information in mind while engaged in processing other material (i.e., other steps in the instructions). Additionally, however, these children were frequently described as having difficulty retrieving information that was previously learned. One possible reason for this difficulty may be that these children had more difficulty creating long-term representations of new material, and so the poor quality or nonexistent representation could not be retrieved at later time points. Another explanation could be that retrieval from long-term memory is problematic. That is, these children may create long-term representations in a manner similar to other children, but have more difficulty retrieving them when needed. It is unclear whether a working memory impairment may

play a role in limiting the creation or retrieval of long-term representations in these children, or whether this difficulty represents an additional memory problem. Difficulty forming long-term representations has been found in children with SLI (Evans, Saffran, & Robe-Torres, 2009), but has not been systematically investigated in children with working memory impairments. Finally, concerns regarding attention were reported in that students were observed to be easily distracted, but not necessarily in a disruptive way. This description of the attention difficulties of these children is consistent with previous reports of low working memory groups (Alloway, *et al*, 2009).

A novelty of this study is the qualitative descriptions of students' academic profiles. Typically, descriptions of academic profiles of children with working memory impairments are based on results of standardized assessments and experimental measures. For teachers, standardized measures and research tools are likely difficult to access. Teachers may not know which measures are appropriate, how to administer tests, or how to interpret results. Additionally, schools often wait until later grades, when students' cognitive development is more stable, to conduct formal testing in an effort to gather more accurate results (Cohen, 1959). Waiting for formal assessment may create issues for students and their learning. If teachers are not aware of students' cognitive abilities and therefore their instructional needs, students are at risk of struggling with school more than necessary. The qualitative descriptions given by teachers in this study for students with working memory impairments offers an accessible resource that may help teachers recognize the challenges faced by struggling learners in their classroom.

Individual differences in behavioural characteristics, social characteristics, and family support for academics were found with the current group of students. There was

significant concern for some students' poor social skills and/or general behaviour; however each student was unique in these areas. Again, the result that some students, but not all, are affected in the behavioural and social domains of life as a result of their working memory impairments is supported by current literature (Kaufman, 2010). As an example, Barkley, (1997) discusses how working memory has an important role in reading social situations and integrating this information with long-term knowledge to act appropriately. Barkley also discusses how working memory plays a role in impulse control. This theory may apply to some of the students in this study. Particularly, it applies to Student C who has trouble keeping comments to himself during instruction time, and to Student F who often responds inappropriately to social conflict.

One of the identified students did not fit with the other eight students with working memory impairments. When speaking to her teacher, this student was described as a model student who was progressing well through the curriculum. Her teacher did not use any extra strategies in teaching this student, nor did she have any concerns for her academics. Additionally, the teacher's classroom routines were typical when compared to other teachers' routines in the study.

One possible explanation for why this student did not fit the same learning profile as the other students in the study is misidentification. There may have been an issue with the assessment of the working memory measure and the age of the child. This student was the youngest child in the study, and the only one in grade one, and the AWMA measure used is less accurate at identifying younger children with working memory impairments as the tasks are difficult for younger children (Alloway *et al*, 2008). Finally, the student may have been affected by anxiety or shyness during assessment thereby

negatively affecting her test results. Further research is needed to explore whether a children with a working memory impairment can present without academic difficulties.

Adaptations made by the Teachers

In response to their students struggling, the teachers in this study reported that they had adapted their teaching. Eight of the nine teachers interviewed discussed a combination of effective strategies they used to teach their students with working memory impairments. The specifics of how teachers used the strategies differed, but at minimum three teachers spoke of using each strategy and often five or more used the strategy. The thirteen effective teaching strategies discussed include: one on one support, building on the basics, extra practice and repetition, prompting, chunking of information, check for understanding, student-teacher conferencing, minimizing distractions, teaching students how to use tools, positive reinforcement and building self-esteem, play-based learning or making material meaningful, accommodate and/or modify assignments and assessments, and modelling. How teachers implemented these adaptations looked different in each classroom. Most strategies helped students in one or more of three ways: reducing cognitive load by simplifying material, reducing cognitive load by connecting it with existing knowledge, and focusing attention.

Strategies that reduce cognitive load by simplifying the task itself assist students by decreasing overall storage and processing demands. Many activities in the classroom have been found to exceed the storage and processing capacity of children with low working memory, as demonstrated by a comparison of academic measures and working memory tasks (Gathercole & Pickering, 2000). By reducing the cognitive load,

processing demands are reduced. The reduced demands may make it possible for these children to complete the remaining storage and processing demands of the task successfully. Chunking information, prompting, minimizing distractions, providing tools, and accommodating or modifying the curriculum all involve reducing the cognitive load of a learning activity by simplifying the task. If students are limited by their working memory ability, then reducing the cognitive load would allow them to focus on the most important processing components of a task (Halford, Wilson & Phillips, 1998).

Other strategies are likely assisting students by reducing cognitive load through activating prior knowledge. Information that is repeatedly presented is more likely to be stored in long-term memory (McClelland, McNaughton, & O'Reilly, 1995). Neural signals from long-term memory are known to be slower firing and have longer duration in the cortex than short-term memory signals (Goldman-Rakic, 1992). Activation of existing knowledge supports retention of information in working memory by decreasing demands for storage whereas novel tasks are more taxing on working memory (Kaufman, 2010). Executive function processes, including working memory, work hardest when processing new or challenging tasks because resources need to be continuously spent rehearsing new information to hold it in the mind (Goldberg, 2001). Familiar information activates long-term memory, which in turn, supports retention and decreases the need for constant rehearsing. For example, it is easier to repeat nonsense words that are more related (e.g., pennel*) than unrelated (e.g., daechig*) to known words (Gathercole, 1995). By activating familiar information stored in long-term memory, there is a reduced demand to attend to, and rehearse information in, working memory. As a result, more resources may be available for additional processing.

Several of the teaching strategies reported likely assisted students by reducing cognitive load through activation of existing knowledge. For example, one on one support and student-teacher conferencing offers opportunities for teachers to teach students individually. In a one on one setting, teachers are more likely to be able to make meaningful connections to prior knowledge specific to a particular student's experiences and interests. Similarly, building on basics, checking for understanding, student teacher conferencing, tools (including computer software programs), making material meaningful or play-based learning, and modelling were reported to help students with working memory impairments, perhaps for the same reasons. In addition to activating existing knowledge, other strategies assisted students to continually build high quality representations in long-term memory. In particular, the strategies providing extra practice and opportunities for repetition, and modelling likely assist students by building fluency for novel tasks through repeated exposure thereby facilitating long-term memory retention. Repeated exposure to new material helps students to master skills such as reading or math operations by creating long-term representations and procedures. Once mastered, these tasks require fewer cognitive resources to complete (Berninger & Winn, 2006), which then assists with higher, more complex cognitive functioning.

Other strategies likely assist the learning of students with working memory impairments by helping to focus attention. Focused attention has been found to assist in the retrieval of information from long-term memory storage (Naveh-Benjamin, Craik, Guez & Dori, 1998). It is also the necessary ingredient to initiate learning; attention needs to be focused on the task to be learned, and not on unrelated stimuli, in order for learning to occur (Kaufman, 2010). The teachers in this study used prompting, one on one support,

learning tools, computer software programs, and meaningful material or play based learning provide extra support for learning, all of which were strategies that may assist in focusing students' attention for learning.

Some teachers made mention of the importance of maintaining positive self-esteem and self-concept for their students with working memory impairments. These teachers were particularly aware that their students recognized that they were falling behind their peers. Recognizing the importance of self-esteem was a particularly insightful observation by teachers as it is not typically identified as an important teaching strategy for students with learning disabilities (Swanson & Deshler, 2003). Despite minimal mention in teaching resources, self-esteem, confidence and efficacy have been linked to long-term success in school (Riding & Rayner, 2001). Additionally, anxiety and stress resulting from low self-esteem and confidence have been shown to decrease working memory ability (Schoofs, Preub & Wolf, 2008), thereby causing an increase in students' working memory deficits.

What was remarkable in this study was the consistency in the strategies teachers used to help their students with working memory impairments. All teachers used one on one support, prompting, and accommodating and/or modifying the curriculum. Additionally, the teachers used a combination of the other strategies mentioned. Seven teachers used positive reinforcement, six teachers used extra practice or repetition, five teachers used tools to support learning, building on basics, checking for understanding, and minimizing distractions, four teachers used chunking of information, and finally three teachers used modelling, play-based and meaningful learning, and conferencing.

In using these strategies, teachers demonstrated that they had the ability to recognize a deficit, despite not having a formal identification for the deficit. It should be noted that the teachers did not specifically label students' difficulties as a working memory impairment; however they were cognisant that their student did have significant learning difficulties when compared to peers. Further, they were able to supply effective supports to improve learning. Teachers had an intuitive ability to address learning difficulties related to working memory and provide strategies that assist students with this form of cognitive deficit. That is, the strategies teachers discussed matched and supported the learning difficulties of the students.

Alloway (2012) used an experimental design to explore teachers' ability to define and identify working memory impairments in their classrooms utilizing a checklist of troublesome behaviours designed to identify working memory problems. Teachers were not able to define working memory, nor were they able to effectively recognize the majority of children with working memory problems. Teachers tended to misattribute troublesome behaviours to lack of motivation or daydreaming. However, the present study shows that teachers were able to provide supportive learning environments despite the fact that working memory deficits were not identified or defined in these students.

The ability of teachers to implement the strategies in an individualized manner within the regular classroom is also notable. Demands on classroom teachers are many, and each teacher was able to implement several of the teaching strategies for their individual student while still meeting the needs of the rest of their classes. This suggests that the strategies identified by this study could be implemented in other classrooms where there are students with working memory impairments. This finding has

implications for future intervention studies, which include a classroom component, for children with working memory impairments.

Measuring the effectiveness of the teaching strategies used was beyond the scope of this study. A meta-analysis by Swanson and Hoskyn (2001) identified the eight most effective teaching strategies used in intervention studies for adolescent students with learning disabilities. All eight described strategies coincide with strategies from this study including: prompting, student-teacher conferencing, chunking of information, modelling, minimizing distractions, extra practice and repetition, one-on-one support, tools and making material meaningful. Results from the Swanson and Hoskyn meta-analysis of effective teaching strategies for interventions for students with learning disabilities may be transferable to this study; however further research to measure the effectiveness of the strategies used for primary students with working memory impairments would need to be conducted.

Adaptations Made by Students

The findings that some students made adaptations to their own learning as a means to compensate for their working memory deficits was an interesting result. Beringer and Richards (2002) showed how the brain has the ability to compensate for functional impairments in some executive function areas of the brain by recruiting other regions. While these findings are not directly applicable to the present study, they do demonstrate that use of compensations may have a neurological impact. Interestingly, three of the oldest students were described as using self adapted strategies to ‘cover-up’ their academic weaknesses. This finding relates to the awareness students had of their

impairment. Students' awareness for their learning difficulties suggest that they are self-conscious of their abilities and are trying to hide it from their peers. This reiterates the importance of teachers' strategy to build self-esteem. Further research is needed to understand the developmental and personal characteristics that are likely to lead to the use of effective self-strategies in individual learners.

Limitations

There are some limitations to consider when reviewing the current study. First, the post-positivist paradigm for grounded theory has met some criticism causing even the most practiced researchers to begin to adopt more constructivist views (Corbin & Strauss, 2008). The argument lies in the notion that while the researcher is to have no role in the research, he or she is still constructing meaning from the data and it is therefore difficult to maintain an objective view. To combat this notion, rich descriptions have been provided and interpretations based on scientific literature were used to explain results. Furthermore, grounded theory originated as a methodology to understand the experiences of patients' experiences in hospital settings (Charmaz, 2006). The present study investigates a more objective topic: How do teachers teach students with working memory impairments? There is an implicit understanding that while not all students will be taught effectively using the same strategies, some strategies will be effective for the majority of students. This was evident when several teachers described the same or similar strategies to teach their students with working memory impairments. Additionally, themes were derived from direct, specific examples and explanations provided by teachers that did not require interpretations by the researcher.

Second, time constraints were present during the constant comparative analysis (simultaneous data collection and analysis). This constraint was due to the fast approaching end of school year. Analysis was done after each interview through memo-writing, and reflexivity but coding could not occur until after data collection. Contact with teachers was maintained into the following school year in the event that saturation was not met with the ninth interview however this was not the case.

Third, the student who did not fit the same academic profile as the other eight students raises questions regarding the inclusion criteria used. More discriminating criteria may be required for subsequent studies. This could include age limitations, as the student who did not fit the academic profile was younger than other students by at least one school year.

Finally, the extent to which the strategies in the present study are unique to a working memory impairment or applicable to learning disabilities generally is not known. Many of the strategies identified would be appropriate for any struggling student. Nevertheless, the present findings do demonstrate a considerable consistency in the difficulties experienced by children with working memory impairment.

Future Considerations

Future considerations from this study are many. First, furthering the understanding of strategies specific to working memory deficits versus those that aid students with special learning needs in a more global manner (e.g. learning disabilities) should be investigated.. Furthermore, research could focus on gaining a better understanding of the effectiveness of the strategies used by teachers in this study.

Alternatively, research in the area of working memory development may look specifically at the ability for students to develop self-strategies to cope with their deficits (e.g., when are students old enough to effectively use strategies to help themselves?).

Importantly, the present study may help inform future intervention studies that include a classroom component. It may also be interesting to investigate the learning profiles of students with varying working memory and performance IQ scores to better understand this relationship and how it presents in academic learning.

Finally, knowledge translation of research findings regarding working memory should be considered for practical application by teachers. Teacher training could include specific teaching regarding strategies experienced teachers find effective in teaching students with learning disabilities such as those found in the present study for children with working memory impairments. In addition, the need to understand the characteristics of individual students could be highlighted. In providing such training, teachers will be able to add to their knowledge and adjust their teaching when appropriate.

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APPENDIX A

Below are the teacher's quotes in the order presented in the *Results* section.

Teacher	Page	Quote
D	46	[Student D] has, you know, the best heart... [Her strengths] are helpfulness and, you know, her willingness to try anything and she gets along with everyone. You know, she's just generally very sort of bubbly, and helpful, and pleasant.
C	46	He struggled with choosing good fit books for himself the whole year and I think it had a lot to do with image. Um he's a pretty cool kid. He's got lots of friends, he plays hockey, he's taller than the other kids, he's older than the other kids - he's a January baby. Um, so he's I think... is he a January? Anyway, he's one of the oldest kids in the class and I think that that um... he really needed to like personify that and so he didn't want to show that he was reading baby books, if you know what I mean. So he would choose higher level books that weren't appropriate for him to cover that up.
G	47	She will often tell stories that aren't true, and exaggerate on things, and that, um, due to you know, the students kind of realizing that, they were starting to alienate her a little bit. So, and she she didn't kind of connect the piece, that her story telling was pushing kids away as far as their interest in her and who she was.
G	47	It starts off pretty, you know, "I went here, there"
G	47	[She] gets caught up in going in different directions and maybe not sticking to what a normal child would say.
E	48	Sometimes he needs a lot of assistance; you know to remember [appropriate reactions and problem solving]
E	48	Sometimes he over reacts, and so that makes kids tease him a bit. You know? Like he'll he'll sometimes get really really upset, but because he's sort of putting on a show, the kids don't know how to take it and then they'll laugh and make it worse, so you know I've just said to him to [remember the strategy] – wait and cool off.
F	48	He plays but, his form of play is really um, what's the word? Not immature, but just child, childish

- F 48 Sometimes [the other students] can't stand stuff. Like, you know, the, he'll be very in their space. He's got a big problem with personal space, but for the most part he's pretty good with them
- F 48 With [Student F] it's always... you don't know what to expect with him. You don't know what he's thinking. He'll have his good days, but then he'll have um..... some rough days and the rough days are usually social behaviours too. It's a lot socially. Like he just doesn't know how to play fair with kids, like everything is about him
- F 49 He just doesn't get it. Like I don't know what the process in thinking is, but he doesn't get things that much. Like he just thinks like it's all fun. He he's very.... like with learning, I'd say his learning style, if he doesn't want to do it he'll cause like a scene, and it's really really distracting to the other kids. He'll be like "No! I don't want to do it, this is stupid, I hate this, I hate school", so he gets like oppositional, like defiant sort of and, as a teacher dealing with kind of like the other 20 students in a classroom... my, my best thing is to not even fight it, cause if I talk back he'll talk back to me and then you take away from the others. You waste so much time arguing with him, so sometimes you just have to ignore it, and then I get it done with him alone on a 1 to 1 basis.
- F 49 He tends to, he doesn't have much of a filter, so he tends to speak out, um he tends to pretty much say whatever happens here (points to head), comes out here (points to mouth). Ummmmm, before he can even think about it.... (laughing). So he's very impulsive, um so I found it difficult to um, maintain flow in my teaching when it was sort of peppered with comments from the peanut gallery.
- H 50 I'm not sure um.... support other than school, I don't think he's receiving it and so uh... what he gets at school is all I think he gets academically... um... and so that's that's it.... right?
- D 51 There's like a vision thing, and there's a hearing issue, and there's you know, the decoding, and the spelling, and the printing, there's a lot that she has to deal with

- D 52 Uhhhh, she's struggling because of her reading I think,
- D 52
The reading really holds her back
- D 53 We've stretched her up to [basically the beginning of] grade 2, and this is the end of grade 3 so she's really two grades behind in reading. Um, and sometimes that's generous. It kind of depends on the day. Sometimes she's you know, more confident and she's taking more risks and she's able to sound out the unfamiliar words a little better, but on an off day there's a lot of trouble with accuracy, and with sounding out even basic words
- D 54 When I first listened to her read I noticed a lot of the time she would look at the first few letters and then she would just guess something that started with those first two letters. If it was an *st* word it always happened to be *strong* or *straight*, or *some*, you know, no matter what the word was, it would just automatically go to that word.
- E 54 It's quite slow, well now and now they've changed it, like his level could have been a little bit higher last year, but now they've changed it so we're timing them, and because of that, um, you know if he can't do it in the time given, then you have to bump him down to the next level lower than that one. Um... so the books he's reading, his fluency is pretty good, but it's only level 10, so you know like he's attending to the periods, you know most of the time in his sentences, and he is using uh, like I said, rereading and self corrections and stuff like that.
- F 54 It's the sounds [that cause him to struggle]... yeah, decoding, and the sounds, and he'll basically, he does the right things like look at the pictures for cues, but he'll look more at the pictures than um, look at the actual words.
- H 55 He does do some re-reading if it doesn't make sense. So if he's able to read most of the words he'll go back and fix up... uh, he does stick with it, like he doesn't give up easy. He will sit there, he'll sometimes sit there for quite a while trying to figure out the same word, and you can

- hear him, he talks out loud when he's sounding it out, each sound and sort of talking it though which is good.
- H 55 He has difficulty making connections, he'll make some, but most often not... uh... he has great reading strategies to help him solve words, with the exception of the Chunky Monkey which is the blending, and um..... and chunking, blending, often there's not predictions, and he rereads his work... not his work, he rereads his text if it doesn't make sense and he's stuck
- B 55 When she sees the print visually she can comprehend a little bit
- B 55 If we do a read aloud and you ask her anything about that, she has no information or it's, like I'm sure when she does a retell that its some other story she's retelling
- B 56 She is good at decoding, and where she breaks down is in understanding and now that the books are getting too... have more of a story to them, it's becoming a little bit more difficult for her to understand and to do well on the computer tasks that we have.
- B 56 If... the average student, if there's a word they don't know they'll say, "Well what does this mean?" you know, it's hindering their comprehension, where as she'll read all of them, but not understand anything, but there wouldn't be, like she couldn't self assess and say, "Hmmm.... it's this word here that's causing the problem." As far as she's concerned it's, "I read it, and I'm good to go!" you know, especially when it comes to nonfiction. She'll always say, "I'm ready for my test!"
- D 56 It seems to be, yeah. If she's following along um, she, you know, she knows that she needs to follow along with her finger but she's not always able to do that because sometimes she's distracted and things like that, you know. She'll kind of be staring off in space. She doesn't always have her finger pointing in the right place. Um, it seems to be if she can listen and hear the story you know as somebody else is reading it then she's able to put up her hand and answer lots of questions.

- E 57 With him, trying to get him to do more predictions, and inferencing, and like his connections, like he sometimes, like his text to text, or text to self connections are kind of narrow. Like, he will only talk about certain things, a lot of times when you say you know well, "What does that sort of make you think of, or what connection can you make?" he can't give anything, or or just it's always the same one, it's like you know, "I made money and I went to get candy at the store." It's something that's not really a connection to the book.
- G 57 Right so as far as missed cues or anything like that, there were no, there were no mistakes made, which is strong, you know, and then the new element is timing. So as far as timing you know she's still strong in that. Where the difficulty comes, and why maybe she's not at a level 24 would be in the comprehension, in the, you know, the, "Tell me what you remember about the story." So... in the recall of information, that's where the check marks indicated what she told me, the circles indicate what I needed to prompt her to remember, you know by giving her, "Well what happened after... or before, " you know, things like that. So again, she's recalling basic information. I mean it's on topic, it's not like you know she's pulling it out from somewhere else, you know, it's still good, but it's not, not an independent level by any means as far as comprehension.
- D 58 I don't know [what's going on with her writing]. She seems to have a lot of ideas, you know and she wants to write them down, but when they're written down it's all.... not necessarily nonsense, but its phonetically spelled... made up spelling for a lot of the words. And if it's spelled correctly up here it might be spelled differently down here and a totally different way down here.... that kind of thing. So there's no consistent pattern following, or rule... you know, that kind of thing.
- F 58 You can, you can read his writing, like it's not messy, but um... he doesn't have the proper spelling techniques yet. He reverses, like there's a lot of letter reversals.
- B 59 And, well I don't know like if she'll say, you know, um... "I love grandma. My grandma loves me. I love my grandma and she loves me too. I love my grand..." and how, okay! Why? What does grandma do? You know,

what do you do that, you know? And even then, with all the prompting to get something, she still doesn't understand type thing so....

- B 59 When I did procedural writing we were doing brushing your teeth, and it was an assessment task, so I... I can't help her with it, but with a lot of the kids we said, you know, "Pretend you're actually doing it, what are the steps". She could not do that at all.
- E 59 He didn't explain it well enough. I said, so I had him read it to me, and I did exactly what his steps said, so just to, you know try and give him an "Ah ha!" moment, you know. [He said], "Oh, I didn't really write about that, " you know, things like that, just getting him to be more detailed in his work. And again, that was tricky because, you know, there was a lot of steps to write down... He doesn't add enough uh, you know it's still pretty basic.
- A 60 She struggles with every part of math. Can't count by 2s, 3s, or 4s, can't identify patterns, does not know basic numbers.... She doesn't know the basics; she didn't get them from JK, SK, or grade 1. It's like her brain turns off and she gets an overall block.
- B 60 In math, unless you know they've been recently working on that, and sometimes then, but if it's something they've done a week ago then revisiting, chances are she won't remember having... it'll be like she's never done that before.
- D 61 We were figuring out the shapes and she had to name the shape before she could tell me how many faces, edges, and vertices. So, it was a square based pyramid, so I had to show her. She knew it was a pyramid, but she wasn't sure what it was exactly called, so I said, "You look at the base, and what's this called?".... the word just wasn't there. She couldn't come up with the word of what this shape's called. So I put it on, I thought okay, this might be because it's a 3D shape and she's not sure what I'm talking about so I um, took a post-it note and I put it in front of her and asked, "What's this shape, right here?", and I had to tell her what the shape was, and she was like "Oh.... Right right right... "

- G 61 It's kind of strange because you know, you think that, you know "Yes! We got this." Like money for example. We, we started our unit off and we're brainstorming what they already knew about money and she was putting her hand up saying, you know "A quarter is 25 cents", and, and I do recall when we were doing this, she made these comments like, "Oh my dad was telling me this." So again, there's that parental involvement, and what what happens outside of school she's able to bring in, and then it was, I don't know, a day later? A couple days later? And we were doing another activity and it's like, "What's a quarter worth?", "I don't know..." "and so, you know that was something that has really stuck out in my mind is that, the the disconnect, the idea that one day it's good, the next day I don't know what happened to it.
- C 62 So, um, when I did [give tests] Student C really struggled with the concepts. Sometimes it's because he couldn't read the instructions, other times it was because that, that, method of giving information is... was overwhelming for him. It was a lot of writing
- E 63 Well, if I have him retell things that happen in the story, he could tell you some of that, but like I say, he doesn't focus the whole time so he's just... like even sitting, I could talk to him ten times in five minutes about, you know face forward, criss-cross, you know just to get him to look like he's attending.
- B 64 In math, unless you know they've been recently working on that, and sometimes then, but if it's something they've done a week ago then revisiting, chances are she won't remember having it'll be like she's never done that before.
- C 64 You know it's frightening. He doesn't forget. Like, if you make a promise, he won't forget it. So, you know, "Oh [Ms. C], we didn't get to read aloud today! You said we were going to do it at 10:30!" Or whatever, 11, quarter after 11. "Okay [Student C], we'll do it tomorrow." You bet your life he would come in the next morning and say "[Ms. C], put read aloud on the board, you said we could do it." So he would remember promises you'd make to him, but again those fast facts, 5+5, um, 6+4, like those partners of 10, doubles, 6+6... no memory for that kind of thing.

- C 64 More academic stuff yeah, [he has more difficulty remembering]. Although, again, if you asked him to recall something from a text we'd read in, at the beginning of the year, he can tell you what the moral of the story Rainbow Fish was. He could tell you that, and again that was orally communicated.
- D 65 I'd say it... if she has somebody you know watching over, and you know pointing things out then she'll definitely make fewer errors. Like when she does it at home her mom is supervising and, and she makes fewer errors there, but if she's left to her own devices, there's a huge difference between when she's beside somebody and someone's reminding her and prompting her you know, "Stay on the line, think about what you're doing, take your time" that kind of thing. And focusing her on, you know, the presentation kind of idea, and organizing it logically... um... with her math and her writing, if there's somebody there to remind her she does much better than if she's just left to do it on her own.
- B 66 We try to have one on one help with her every day as well. So she's someone in the class that we have uh... decided would benefit, so every day she has 15 minutes of one on one help.
- C 66 [Do] anything one on one because he so... seeks that approval that one on one with him was very effective. So, all the work we did with the ummm, with the uh... volunteers and all the conferencing that we did was very beneficial for him definitely.
- G 67 She loves adult attention... she loves one on one. Uh, she's in her glory when uh when she goes [to see the learning support teacher (LST)], so it's never, never a problem. Ummmmmm, and yeah, she does you know she does as far as the LST that has reported to me, you know she works really hard when she's there. Never an issue with that, so..."
- B 68 Well she started with, you know letters and sounds, then she went to sight words, and when she knew her... you know a certain level of sight words we started with reading at her level... and with the earlier books she made a lot of success with that.

- B 68 Whatever we're working on, she has to have that base vocabulary built in for her whether... because another part of daily five of course is the guided groups. So in guided groups you know she has to have some time to make sure she has that, built that understanding of vocabulary
- G 68 As far as our phonics program, we, in our classroom we do phonics books and we work through them at a progressive rate... she.... We did put her in a year earlier, or a year behind what the rest of [her class] was doing. So although that was maybe not welcomed, or maybe not seen as something good from her parents, and from others, in the end its its worked out well because she she needs, she needed that, the review of the basic phonic skills in order to build upon what... what uh... what she needs to do.
- B 69 If she had some base in that, that, like if she knew how to count blocks for example when we were first doing addition, then once she understood that she could continue on.
- H 69 Just the continued, like repetition of getting him to reread books that he's read... That's been good and he's successful with that because there's a familiarity to it
- D 69 Sending her to extra reading practice, and encouraging her to, just like all the other kids, read every day... and um.. uh, she has been given certain things she can do at home, um, to do extra reading practice
- E 70 We have a booster club after school. It's Monday and Wednesday for grades 1, 2, and 3, and really wished he'd gone in that because they do Destination Reading, and they do all sorts of programs. It's sort of like a tutoring program after school. It's not like a homework club, cause we had a homework club too, you know a lot of my kids were in that... but you know he would have benefitted from being in that.
- B 70 She likes working on the computers, and that's where she's almost like the furthest one in the class on Essential Skills. So, she really likes that and I think it's a combination of the visual and the oral, or ya.. the visual and oral together and... just the practice, practice,

practice. So, she likes that, of course.

- B 70 It's repeat, repeat, repeat for her. Definitely not going to be, we're looked at it once and we're going to understand it.
- E 71 He can't sit still very long and he has a very short attention span, so you're always trying to draw him into the activity, redirecting him," and later mentioned, "I just find he's better when he's uh, even when he's in the small group you have someone directing him, you know just getting him back on task with things
- H 72 I'll be like, "Oh yeah, [Student H] you're doing the next one" and I sometimes will tell him before, so that he sees someone do it first... because if i just call on him, like I never want them to feel centered out and uncomfortable, so I'll tell him ahead of time.. "You're going to be doing the next one. Be thinking about..." or you know, "Watch so and so, they're going to do one now".
- H 73 I'm doing.... a combination I would say, like I'm doing a lot of... well you can group it as one, but I do sort of like signalling him right... so the verbal... and so auditory I guess, and then um... I will point to... like, whether like he's looking on... I'll direct where he's looking right, so I'm I'm kind of focusing him wherever my pen is, or wherever my finger is... otherwise he'll kind of just... and he's cooperative, but um... just like getting him to focus on that... or sometimes I'll cover up some of it, so if we're doing addition at the top and subtraction at the bottom, I don't want him to get confused with that so I'll just sort of take a paper and cover the bottom half.
- B 74 That's why I've been working on, trying to be more concise in my instruction time... and so that's really hard because you start talking away, you've got all these words and I think especially with someone like [Student B] you're saying all these words, but that's not really the meat of what you're doing.
- F 74 I think things for him need to be broken down, and like chunked out always... like everything needs to be chunked. If you're going to be reading something, chunk out those lines for him... So chunking it would definitely

be a strategy for him. You just have to literally simplify things for him.

- E 75 A lot of times I'll get him to do some self-talk, you know explain it back, you know, just talk to yourself and talk out loud as to what you have to do, and sometimes I just have him give it back to me as well just so I know he knows what to do instead of always hearing it from someone else. I just find that because of his attention span it helps.
- E 75 Well I just want to know if he's even listened well enough to even understand what he's supposed to be doing right? So, yeah, and then if he has a question, I just want to see what he remembers about what he's supposed to do, but he's quite distracted at, you know, tasks too... so...
- G 75 Always, always check in with her, cause she's she's developed you know, some amazing strategies with copying from others, with what it looks like is you know working. She looks like she's working but in reality she's not, and and its not until afterwards you look at her work and it's like, "Oh my gosh! You you didn't catch that instruction, or you didn't get it" kind of thing.... You know, just the yeah...keep her close.
- C 76 [If I taught him again next year] I think I probably would have um, taken the time to set up a permanent meeting with Student C. Um, every Wednesday or something to have him, um, discuss one particular reading strategy, or, um, one particular writing strategy
- E 76 I conference with him a lot, you know, to see what he's getting out of his math, or if they're writing or reading, um, more so than others because he's you know a lot lower than others
- E 77 I've been using a timer. Sometimes I use timers for tasks, 'cause it's kind of fun, but it also helps keep him focused because he'll think, "Okay! I gotta get this done before that buzzer goes off!"
- E 79 I think the biggest thing is the social stuff. I have to strategically place him in a group, or somehow work it out that way when he's doing anything, even with a

buddy, one person. I really, you know, I really don't want one person to give him negative feedback, "Oh I don't want to be your partner". You know, I work really hard on that cause to me the kids' self-esteem is the most important thing in the classroom that I work on.

- E 79 He really does like to, he really likes to do a good job. Like, when he's writing, he'll like, and when we do 'Bump it up' strategies he'll be like "I really tried to bump that up because I put a juicy word in there", or, "I put a bossy verb". And he's really understanding that, and like we're trying to do a lot of descriptive feedback activities, and and the more praise he gets, the better he seems to handle, you know, his workload.
- G 80 At the beginning [of the year] she would seek and need a lot of assistance because she didn't have the confidence to to do it on her own. Um, so we adjusted some of the expectation and the curriculum that we were giving to her and that allowed her to gain the independence and gain the confidence. So that has really helped throughout the year and that has made a difference.
- C 80 Positive reinforcement all the time was like the baseline for [Student C]. Like telling him that when he came in and sat down quietly without interrupting or goofing off, "[Student C], I really love how you came and sat down, you did a great job". Like constant stream of, of positive reinforcement for every little thing. That was so important for him and it really, it really helped to um... what's the word? Uh, bring about more of that positive behaviour.
- E 81 I find that the more he's interested in something, the more that he'll be able to remember. You know like he can tell me all about Canadian animals and sports, but he might not be able to tell me about capital cities and things like that.
- C 81 teaching them to learn something without them knowing that they're learning it" really worked for Student C
- C 81 My math program, like I said, was pretty play-based and um, a lot of portraying your understanding in pictures, um, showing me with cubes a pattern, things like that. He

- was pretty good at that stuff. But paper and pencil... he really struggled
- C 82 He LOVED the math games, and I noticed a big improvement um, in the whole... I only started doing it later like in the spring, but I did notice an improvement and an increase in enthusiasm in the whole class uh... and I know that [Student C] in particular really enjoyed that. So that seemed to help him a lot.
- E 82 We just finished probability and he didn't really have a problem with that because we were doing a rolling dice game and they had to graph it to see which number won, and a coin toss, and you know, just remembering to the tally marks right away, you know and the spinning activities. Like, he did okay on that, and if he didn't like they were in groups so, you know, we would just pick it up from someone else.
- E 82 I do a lot of quality daily physical activity in my room for DPA because I just find that, you know, after 10, 15 minutes, I just find, okay, let's get up and you know, do something on the Smartboard. And there's literacy games where you throw a koosh ball at the Smartboard, and it hits a coloured circle and it tells you to do 10 sit-ups, or say "rowboat" 10 times, and it's just fun stuff you know, to just get them up, get them moving. Um, different activities like that and um, I have this tennis ball, and you throw the tennis balls in the air and it's a scramble, and they have to find someone to match up the same letter, or match up the same word, and I just have to really do that.
- H 83 Our class is very rich as far as like what I'm trying to offer and so you'd think that he would pick up on something just being... you know what I mean? Like being immersed in the classroom, immersed in balanced literacy
- E 83 We do little placemat activities. It's a Berry Bennet strategy where it's a great big piece of paper and they all have a section to write in, and then they have to uh, they have to talk about it and then write down the most important things that they come up with in the middle. You know, so there's so many ways that he's getting modelling in the classroom.

- G 84 I have what we call Experts, so kids have, you know, completed a task and everything is corrected. They turn around and help others, so um, you know [Student G], she gets through it
- H 85 As far as his spelling words [he] did rhyme families and everyone else was sort of working on um, like harder words, but he's still working on like the '-at' family or he's still working on, you know those kinds of things
- D 85 So we tried her out with the regular spelling list and it wasn't really going very well. She would do the exercises perfectly fine, but then when it would come to the actual dictation, it was always you know, 5 out of 13 or something like that. So we changed her to um, a basic phonics based kind of spelling list where all of the, you know, they're all word families, words that rhymed with each other...that sort of thing.
- F 86 Actually after the February report cards, that's when they noticed, Hey, something needs to be in place for this kid." Like he's not getting the concepts, like the program... like the grade __ curriculum. So everything's been modified, every subject has been modified for him.... All the writing and reading subjects. So math, science, social studies, and um language arts.
- B 87 There's not any one strategy that's you know, that she's going to take and just sail with but uh.. [we're] just trying to figure out what's next
- D 87 Maybe [her difficulties are] something that's, that needs to be worked around rather than fixed, because there might not be any way of fixing it. That kind of thing...
- H 88 He will stick to it. So if he's trying to figure out a word he doesn't easily give up, even if he hasn't... even if he doesn't and when he's sounding out I think he's never going to get it, he still will do it, or he'll skip it and go on. Like he's he's good at he often will use Stretchy Snake, he often will use Eagle Eye we call it so it's just looking at the pictures. Skip the Frog, so he'll skip over it and comes back but finishes reading the sentence and comes back and thinks about what makes sense there or guesses. Um, but the hard one for him is Chunky Monkey

and getting it into chunks and remember, “Okay i-n-g is – ing”

- B 89 Now, she can use a tool, you know so I guess that’s one thing that’s you know like whether it’s the math wall, or the word wall, or... and saying well these are things, tools to help you, you know if you can’t add, you need to know how to use a calculator, in spelling you need to know how to use a dictionary, and teaching her how to use tools like that....but it’s a slow process.
- D 89 When she does need words, you know everybody is encouraged to come and see me for their words if they need them. Um, and she knows how to use a dictionary, um and she’s pretty savvy with the computer, you know, being able to problem solve and use her strategies, and she can look up things on the computer and things like that.
- D 90 I was trying to make it you know as non-issue as possible to make sure you know she wasn’t getting anxious about it, that kind of thing, and um, but you could tell she was, you know, “Why can’t I? I don’t know... Why can’t I remember this?”
- D 90 That was the big, you know, bell ringing thing for her mom in September. Her brother who’s going into SK, now he’s at the end of SK, he’s able to do things better than she can now. And now [Student D] is realizing it, you know, that was at the beginning of grade __ and now she is figuring things out, you know. That he could read things better than she could.
- D 90 I think she hides [when she doesn’t get things] pretty well. She’s got all these you know coping strategies I mean she’ll ask her neighbour, that kind of thing. People will, when she’s reading, um, when we’re you know in a group on the carpet and she’s volunteered to read or whatever, if she’s volunteering to read whatever, people will whisper the word to her, you know under their breath.
- D 91 The other girls are quite strong readers and writers, and yeah so she tends to kind of rely on them a little bit, but not sitting right near her or next to her or anything in the class, but she gravitates towards them. Like, if they’re

given groups to chose, you know there's usually at least one of those girls in her group. She doesn't she doesn't seem to be the leader; you know that kind of thing, but the girls kind of look after her. Put it that way.

- G 91 She's an excellent um.. copier... just so you know. So she can be here, and someone's over there and she can read upside down. I've been amazed with what she can do.
- C 92 He also has developed incredible coping skills cause he is weak as a reader, and he's weak um, in numeration. So, he developed incredible coping skills. He could take things in, use classroom cues like I've never seen before. He was able to um, like, and it's not even like just copy off what someone else is saying, it wasn't even like that - it was just using anchor charts, resources, word wall, things like that so that his weaknesses wouldn't show.
- C 92 He had to [use classroom resources to his advantage]. And he knew that if he didn't, he would look ... quote-unquote stupid or he would look you know, he would look low, he would look like a low reader ...um ... And it took I would say, probably say, six months before he would read out something from a shared reading piece, or something for the class. Um... but he did build confidence as the year went on and he did show improvement, um... but not as much as I had hoped
- C 93 He listens like to EVERY word that you say. He's very in tune with all of the teacher's actions. He can anticipate um using cues like, uh, he would know if I photocopied something and put them by the science duo tangs he would say "Oh, so we're learning about that next period?" He would, he would, really to the point where he was like in my personal space cause he would use like my behaviours, like my teacher behaviours to sort of estimate or, or, or guess or predict what was going to happen, um, so he could be ready. He also likes to sort of be the one that's in the know. So, but that actually benefits him in the classroom. I think it annoys the other students at sometimes but um, and it does get a bit frustrating cause he does get a bit comfortable with you and he gets a bit familiar and you have to, you know you have to build up that wall and make the, make the boundary really clear between teacher and I'm not your friend, I'm your teacher.

- C 93 His writing would be very, VERY, superficial. Wouldn't use a lot of descriptive words, a lot of juicy words we call them. Um, basic vocabulary, stuff like that. His handwriting, again, one of those coping skills, so neat and tidy. He can copy notes from the board so fast, and so neatly because then when he hands in his work, it's perfection. It's not his own work, but its perfection at first glance. Yeah. Like if he, he, like I said, copying notes off the board, um for science, or um... not that you do that a lot in grade 2 but, any time we were doing a fill in the blank thing his handwriting's impeccable.
- C 94 He keeps his desk neat and tidy, very organized, knows where everything is all the time, like doesn't want it messed up because if he lets that slide then something else might show. You know what I mean?
- C 94 It's almost like its compensating, like uh... uh... a person who is visually impaired can hear 10 times better than a person who's not. It's almost like he's built up these other skills to to compensate for what's missing. It's incredible.

APPENDIX B**Teaching Strategies Addressing Working Memory Differences
Information for Teachers****Information about the Study**

We are conducting an extension to the ongoing study in which a child in your class is participating, Language, Reading, and Math Achievements in School Age Children, being conducted by Dr. Lisa Archibald and colleagues. We would like to investigate some of the effective teaching strategies being used by teachers of students with a range of scores on our working memory measures. Our aim is to better understand how these children effectively learn in the regular classroom setting.

Procedures

For this study, teachers will be interviewed for approximately 45-60 minutes by Laura Vanderlaan, a student completing a Masters degree under Dr. Achibald's supervision. The interview will take place in May or June, 2011, at a point when teachers know and understand students' education needs well. In the interview, teachers will be asked questions related to the strategies he/she found most effective when teaching specific children. Should a teacher have more than one target child in the classroom, she/he will be asked to comment on how the strategies used are adjusted for each child but the additional interview time is not expected to be significantly more. Based on the analysis of the first interview, teachers may potentially be asked to participate in a second interview. Following analysis of the interviews, all of the teachers participating in the study will be invited to participate in a group meeting focusing on common themes from the interviews. The students will not complete any direct research sessions as part of this study, and consent has been obtained from the children's parents and guardians to discuss their child's learning.

Comfort and Safety

There are no known risks or direct benefits associated with participation in this study. The results may help us understand effective teaching strategies that address working memory differences in the regular classroom. Participation in this study is voluntary. You may refuse to participate or withdraw from the study at any point without implications to you or your work.

Confidentiality

All of the data collected from the interviews will be kept confidential and used only for research purposes. Names or any identifying information will be removed for analysis and publishing of the results. The data will be restricted to the researchers involved in this study only, and will be destroyed within seven years of the completion of the study. If you would like the data to be destroyed sooner, please contact Lisa Archibald.

APPENDIX C**Teaching Strategies Addressing Working Memory Differences
Information for Parents****Information about the Study**

We are conducting an extension to the ongoing study in which your child is participating, Language, Reading, and Math Achievements in School Age Children, being conducted by Dr. Lisa Archibald and colleagues. We would like to investigate some of the effective teaching strategies being used by teachers of students with a range of scores on our working memory measures. Our aim is to better understand how these children effectively learn in the regular classroom setting.

Procedures

For this study, your child's teacher will be interviewed for approximately 45-60 minutes by Laura Vanderlaan, a student completing a Masters degree under Dr. Archibald's supervision. The interview will take place in May or June, 2011, at a point when your child's teacher knows and understands your child's education needs well. In the interview, the teacher will be asked questions related to the strategies he/she found most effective when teaching your child. Based on the analysis of the first interview, teachers may potentially be asked to participate in a second interview. Following analysis of the interviews, all of the teachers participating in the study will be invited to participate in a group meeting focusing on common themes from the interviews. Neither you nor your child will complete any direct research sessions as part of this study. Your consent is required in order to allow us to conduct these interviews with your child's teacher.

Comfort and Safety

There are no known risks or direct benefits associated with participation in this study. The results may help us understand effective teaching strategies that address working memory differences in the regular classroom. Participation in this study is voluntary. You may refuse to participate or withdraw from the study at any point without implications to you or your child.

Confidentiality

All of the data collected from the interviews will be kept confidential and used only for research purposes. Names or any identifying information will be removed for analysis and publishing of the results. The data will be restricted to the researchers involved in this study only, and will be destroyed within seven years of the completion of the study. If you would like the data to be destroyed sooner, please contact Lisa Archibald.

ETHICS APPROVAL



Use of Human Participants - Ethics Approval Notice

Principal Investigator: Lisa Archibald
Review Number: 179195
Review Level: Full Board
Approved Local Adult Participants: 12
Approved Local Minor Participants: 0
Protocol Title: Working Memory in the Classroom: Best Teaching Practices
Department & Institution: Communication Sciences & Disorders, University of Western Ontario
Sponsor:
Ethics Approval Date: May 02, 2011 **Expiry Date:** August 31, 2012

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
UWO Protocol		
Letter of Information & Consent	Parent	
Letter of Information & Consent	Teacher	
Assent		

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The UWO NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

This is an official document. Please retain the original in your files.

The University of Western Ontario
Office of Research Ethics
Support Services Building Room 5150 • London, Ontario • CANADA • N6A 3K7
PH: 519-661-3036 • F: 519-850-2466 • ethics@uwo.ca • www.uwo.ca/research/ethics

CURRICULUM VITAE

Laura Vanderlaan

EDUCATION

Master's of Science	Western University, Speech & Language Sciences, 2012
Bachelor of Education	Queen's University, 2009
Bachelor of Science, Biology	Queen's University, 2008
Bachelor of Physical & Health Education	Queen's University, 2008

PROFESSIONAL TEACHING EXPERIENCE

Standing Stone School	Oneida Nation, ON, Dec., 2011 - Present
Algonquin & Lakeshore	Napanee, ON, Jan. – Dec., 2010
Catholic District School Board	
Penta International English	Taipei, Taiwan, Jul. – Aug., 2010

RELATED EXPERIENCE

Conference Presentations	Canadian Society for the Study of Education – University of Waterloo/Wilfred Laurier University, May 2012
Research Assistant	Western University, September 2010-Present

AWARDS

Ontario Graduate Scholarship	2011-2012 Award Winner
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PROFESSIONAL AFFILIATIONS

Ontario College of Teachers	June 2009 - Present
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