The Effect Of Interactive Whiteboard Use On The Engagement Of Students With Intellectual Disability In Early Reading Lessons

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PhD Thesis

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ABSTRACT

Reading is an essential life skill in which many students with intellectual disability struggle to achieve functional independence (Downing, 2005). The ability to read is critical for successful engagement in school, for participating in leisure activities and for undertaking daily life tasks (Copeland, 2007; Saunders, 2007).

As reading is such an important life skill, the focus of the project was on the impact of the use of an interactive whiteboard (IWB) on the engagement of students with intellectual disability in reading lessons. The research available at the time this research commenced suggested that implementing IWBs as a tool for scaffolding learning when teaching, would help to increase students' levels of engagement in lessons (Moss et al., 2007; Tanner & Jones, 2007) and the use of ICT holds the promise of being able to teach students to read and prevent reading difficulties (Snow, Burns, & Griffin, 1998). Three categories of student engagement behaviours were the focus of the study; task, affective and cognitive engagement. To investigate the impact of IWB use the levels of these engagement behaviours in lessons using an IWB were compared to levels of engagement in lessons using more traditional, desk top activities (non-IWB). Observational ratings of student engagement were undertaken from video recordings of each lesson, using a scale developed by the researcher.

This research project worked with five junior primary students with intellectual disability, all of whom were identified as having major difficulty in reading. Their class teachers first identified the students, then pre-testing was undertaken to identify which skill should be targeted. Ehri's Phases of Reading Model (Ehri, 1991; Ehri & McCormick, 1998; Ehri & Robbins, 1992; Ehri & Wilce, 1985) was used to guide the researcher as to the skill to be

targeted and the type of activities that could be used to help teach the students.

A single-case experimental approach was used, incorporating an Alternating Treatments Design (ATD). The ATD enabled the two treatment conditions to be administered across a sequence of consecutive lessons. Mayer's multimedia learning model (Mayer, 2001), incorporating Sweller's cognitive load theory (Sweller, 1999, 2004) underpinned the approach to the design of lessons, while issues identified in the IWB literature were considered so as to maximise the benefits of teaching with the IWB.

The students' rate of acquisition of reading skills was assessed and compared across the two conditions. For the comparison of levels of engagement in the two conditions three forms of analysis were used: visual analysis which is typically used in single-case experimental research; comparison of the percentage of non-overlapping points in the profile of measurements in the two conditions; and randomisation statistical tests.

The five students all acquired knowledge in the aspect of sounding and blending or letter/sound correspondence that was the subject of their lessons. However, neither condition led to a faster rate of acquisition.

The analysis of levels of engagement indicated that there was no consistent pattern of difference between the IWB and non-IWB conditions across the three domains of task, affective and cognitive engagement. Two students were consistently more engaged in the non-IWB setting. One student showed a tendency to be more engaged in the lessons with the IWB, while the levels of engagement for the other two students showed no consistent differences across conditions for any of the three categories of engagement. Even in this small group of beginning readers, the results suggest that there would be a need for the teacher to make individual decisions about whether or not to use an IWB to optimise level of engagement. The claims for the effects of use of IWBs are discussed in the light of these results.

A considerable difference in language output was observed between the two conditions. Specifically there was evidence of a higher level of relevant verbal elaboration in the non-IWB condition. This result is an important finding as production of language, particularly elaborated or connected language, helps to build knowledge networks and deepen understanding of the task and therefore comprehension. The elaborated language in the non-IWB condition was found to be up to twice the amount of language produced in the IWB condition.

The making of errors or the perception of task difficulty did have an impact on student engagement. One student in particular found it very difficult to become re-engaged with a lesson after he had perceived he had made an error while another student needed to experience a familiar activity before being exposed to a novel activity. Both instances highlight and reinforce the need for lesson structure to scaffold the student from the familiar to the unknown.

Implications of the findings and suggestions for future research are presented. The implications for future research focus on the design of software and the integration of technology into lessons that supports student learning outcomes while developing cognitive skills and promoting relevant, elaborative language production.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed *Carol Le Lant*

Date 20th April, 2015.

ACKNOWLEDGEMENTS

Perseverance is not a long race; it is many short races one after the other.

Capt. Walter Elliot
Scottish Politician 1888-1958

The path trodden in preparation of this thesis was indeed filled with many short races one after each other. Some races felt as though they were filled with obstacles such as quick sand and deep rushing water and others were where much calmer waters were felt, but throughout, there was always encouragement, support and advice to help me reach the finish line of thesis submission. To those people and organisations I now extend my deepest gratitude:

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Finally, to my children, Matthew and Morgan, thank you for putting up with me and my eternal studies, and the pressure it often exerted on our lives. I love you dearly.

1. INTRODUCTION

"The beautiful thing about learning is that no one can take it away from you."

B.B. King

On any given school day Special Class teachers are confronted with students and their various arrays of emotions and attitudes towards school and learning. A fairly typical example is a morning in which young James storms into the room, punches his teacher in the stomach, kicks another student and then puts himself outside with a very loud Hmph! Not only is James upset and moody, but the rest of the class is now unsettled. Welcome to a junior primary Special Class, a class of eight students with intellectual disability.

In such a class, the teacher's challenge is to connect with the students, recognising that before the school day begins, they may encounter situations that impact on their emotional and cognitive state which can then influence the other students in the class. Motivation to learn and engage in the curriculum is often not present, so the teacher needs to 'win' them over by using activities that are interesting, appealing and with educational purpose. As most of the students struggle with their speaking and listening skills as well as reading and writing, a relatively large proportion of the school day is spent on literacy across the curriculum.

The early development of literacy skills can be encouraged by providing high quality, systematic and explicit phonics instruction (Rose, 2006; Weinstein & Mayer, 1986). Systematic and explicit phonics instruction is a method used to teach students the grapheme-phoneme (letter-sound) correspondences in written language and how to use these correspondences to read and spell words. Phonics instruction is systematic and explicit when all the grapheme-phoneme correspondences are taught to students in a clearly defined sequence (Rose, 2006, p. 17).

So, how to overcome the impact of incidents like the one described above? On the classroom wall, there is an interactive whiteboard (IWB), a large touch sensitive screen connected to a digital projector and computer, a piece of equipment that is purported to engage students in learning through its multimedia, multisensory capabilities (BECTA, 2003; Cogill, 2003; Higgins et al., 2005; Smith, Higgins, Wall, & Miller, 2005). Certainly, many teacher and student self-reports of the use of IWBs in classrooms have been encouraging (Levy, 2002; Miller & Glover, 2002; Wall, Higgins, & Smith, 2005), so the intention of the researcher was to investigate whether the use of an IWB led to increased engagement and reading performance with students in special class settings with intellectual disability, in particular in the acquisition of an aspect of phonemic awareness. A comparison of lessons using an IWB and lessons not using an IWB (non-IWB) was made to discern whether or not the use of an IWB engaged students for longer periods. If this occurred it would be significant because increased engagement levels can lead to increased learning opportunities for students (Fredericks, Blumenfeld, Friedel, & Paris, 2003; Fredericks, Blumenfeld, & Paris, 2004).

The impact of the IWB on student engagement and performance were the key points of focus of this study.

Significance of the Research

At the commencement of the research project, there were very few systematic studies conducted on the use of IWBs for the teaching of students with intellectual disability, in particular studies comparing the use of IWBs and traditional desk top teaching (non-IWB) methods for the acquisition of reading skills with students with intellectual disability. As recently as (2014), Starcic and Bagon made a similar observation after conducting a literature review, stating *“Research and development of information and communication technology (ICT)-supported learning for people with disabilities has not received adequate attention”* (p. 1).

The potential to engage students with intellectual disability with this technology brings the possibility of a new, accessible dimension to teaching. The planned research focused on two areas:

1. Reading, or more specifically, the acquisition of an aspect of phonemic awareness. A framework will be outlined that can be used to guide the selection of reading activities that will then be used with students with intellectual disability who have developed few phonological awareness skills.

2. The engagement levels of the students participating in the intervention. Engagement will be measured across three domains: task, affect and cognitive, which will be expanded upon in the section on Engagement and the Method chapter.

Overall, the biggest challenge when using IWBs appears to be in changing the learning outcomes of students. No consistent significant effect has been identified across student performance in Mathematics, English or Science (Higgins et al., 2005; Moss et al., 2007). Schuck and Kearney’s (2007) Australian literature review noted that *‘There is a lack of evidence on the impact of IWBs on student achievement and performance outcomes’* (p. 13) The same point has been made by Glover, Miller, Averis and Door (2005) when they state in relation to the introduction IWBs as a teaching tool that ‘*there is almost no evidence of measured gains in pupil progress and long-term achievement as a result of changed teaching and learning approaches’* (p.166).

Research Aims and Research Questions

Interactive Whiteboards have the potential to engage students with intellectual disability in the learning process, and with the rapid uptake of IWBs in schools across Australia, it is important that researchers of students with special needs examine the effects of their use. For this project the broad research question was:

What impact do interactive whiteboards, used as a teaching tool, have on dimensions of engagement and performance of reading skills of students with intellectual disability, when compared with parallel lessons taught without the use of interactive whiteboards?

Specific questions

1. Can the use of IWBs increase the level of task engagement behaviour, affective engagement behaviour and cognitive engagement behaviour in reading tasks when compared to traditional teaching methods?

2. Are the reading (grapho-phonic) skills attained at a faster rate in the IWB condition when compared to lessons taught without the use of IWBs?

Approach and Structure of the Thesis

Chapter 2 will outline the theories that will be used to underpin the research for this thesis, commencing with the phases identified by Ehri and colleagues (Ehri, 1991, 1995a; Ehri & McCormick, 1998; Ehri & Robbins, 1992; Ehri & Wilce, 1985) that students go through whilst learning to read. This model was helpful in identifying the aspects of reading students have reached or those with which they are struggling. A selection of teaching activities follows the introduction of the model, these activities having been shown to engage and assist students in learning to read.

The concept of Intellectual Disability is then introduced, with a description of how intellectual disability relates to the students participating in the research.

A cognitive framework, Lawson's (2008) COATSRUAM Framework, provides a broad description of the cognitive phases of processing which underpin this research project. This framework was useful as it guided the instructional process required to minimise cognitive overload, maximise student engagement whilst utilising the benefits of multimedia (IWB). Following this, there is a review of research into student engagement and IWBs and the perceived benefits and disadvantages when the IWB is used as a teaching tool and for the enhancement of student learning.

Chapter 3 outlines the methods undertaken in the research. This includes details of the characteristics of the five participants and how they were selected; an explanation of the research design and of the measures used, as well as how, the data once collected, was analysed.

Chapters 4 through to 8 detail the results of each of the five participants in regards to their individual levels of task, affective and cognitive engagement, culminating in the Results Summary Chapter at chapter 9, whereby the findings from the case studies are amalgamated to enable a summary of the results.

The final chapter, chapter 10 discusses the research questions in relation to the results, and the implications the findings have for teaching, theory and IWB software creation, and future research opportunities. The issues and claims raised in the literature review (chapter 2) are explored in relation to the results of this research. Limitations and delimitations are identified before concluding the thesis.

2. LITERATURE REVIEW

Learning to read

Reading is one of the foremost means of conveying information and ideas (Saunders, 2007) and an essential life skill that leads to success in today's society (Downing, 2005). Reading is also one of the most important skills that students acquire in their early years of schooling (Saunders, 2011). Being able to decode and construct meaning from written material (read), leads to increased employment opportunities, enhances health, safety and welfare, and provides individuals with increased choices on how to spend their time (Copeland, 2007; Saunders, 2007). It is of particular importance that teachers provide literacy instruction to students with moderate or severe intellectual disabilities that will enable them to have access to the important benefits associated with literacy (Copeland, 2007, p. 1). The ability to engage successfully with many academic tasks in school is founded on literacy skills. In addition, literacy skills impact on daily life, enabling an individual to pursue an area of interest helps to build self-esteem and confidence, and supports all individuals to contribute in productive ways to the social and economic activity of our communities (Department of Education, 2005).

Phase view of learning to read

Ehri and her colleagues (Ehri, 1991, 1995a; Ehri & McCormick, 1998; Ehri & Robbins, 1992; Ehri & Wilce, 1985) have proposed a Phases of Reading Model that provides a framework for understanding the basic developmental changes that occur as students learn to read words (Kamhi & Catts, 2005), and builds upon previous models outlined by researchers such as Chall (1983), Frith (1985), Juel (1983, 1991) and Mason (1980). A phase theory of reading acquisition characterises the predominant types of alphabetic knowledge used, and provides a flexible view of the abilities that prevail in the course of reading acquisition. The term ‘phase’ is used to indicate that this framework does not adopt a ‘strong stage’ stance that requires each stage to be a prerequisite for the next. Once students begin to understand and apply the alphabetic process, the phases emerge successively, although students can use processes from more than one phase whilst learning to read. For example, readers in the full alphabetic phase predominantly use grapho-phonic connections to learn to decode words, but may resort to partial connections for longer or unknown words because they are unable to segment the word’s pronunciation into all of its phonemes (Ehri, 2002, 2005).

A benefit of applying a phase view of reading development is that it enables teachers to detect delayed reading progress early and for them to implement relevant teaching strategies that support, scaffold and guide the student to the next phase (Ehri, 2002; Ehri & McCormick, 1998; Hempenstall, 2004). Understanding and interpreting word reading behaviours used by readers who are delayed or disabled, helps teachers to clarify the reading processes used by students during a particular phase, while recognising the constraints that limit students’ attempts whilst they are learning to read (Ehri & McCormick, 1998). This phase view was a particularly useful approach here as the students participating in this research project were experiencing delays in learning to read and were in the early phases of reading acquisition. The students varied in their levels of initial reading skill and were placed within a phase to determine relevant instruction.

Ehri and colleagues developed a five phase reading model. The first three phases, Pre-Alphabetic, Partial Alphabetic and Full Alphabetic could be described as being focused mostly on learning and internalising the alphabetic principle, developing a working knowledge of how to apply the letter names and sounds to decoding words with the correct pronunciation, while building a knowledge bank of words and word meanings (Ehri, 2002, 2005; Mayer, 2008). Students then move into the Consolidated and

Automatic Phases as they recognise that the same phoneme blends across different words represent a consolidated unit such as /ight/ (Ehri, 1995a). This transition enables readers to focus on more complex text comprehension, to gather information and expand their knowledge (Chall, 1979; Ehri & McCormick, 1998; Ehri & Wilce, 1985; Mayer, 2008). It must be recognised, however, that across all phases, the construction of meaning, is the primary goal of reading, though the emphasis on this process changes across the phases. In the following section, a more detailed explanation of phase two is provided as it is the phase relevant to this research project; the students who participated were discovering the alphabetic principle and needed to further their application of the alphabetic principle.

Relevant Phase of Reading

Phase 2 - partial alphabetic phase

Students in this phase have begun to discover the alphabetic principle, that phonemes can be represented by graphemes, and they are becoming aware that these sounds and spoken words are represented in print (Chall, 1979; Ehri, 1995a; Gough & Hillinger, 1980). For students learning to read it is necessary for them to grasp and understand this alphabetic principle (Stanovich, 1986). In this phase, students are also beginning to form connections between some graphemes in written words and phonemes detected in speech. However, they are not necessarily able to consistently apply this knowledge to the written word as they do not possess alphabetic knowledge in its entirety (Ehri, 1991; Gough & Hillinger, 1980; Spear-Swerling & Sternberg, 1994) and words are often misread because not all grapho-phonic cues are used due to the lack of knowledge required to perform the requisite operations (Ehri & Robbins, 1992). Context cues, combined with students' growing alphabetic knowledge, are relied on to guess unfamiliar words, such as drawing on the theme of a story or using picture cues to identify a word in text.

In attempting to apply this grapho-phonic knowledge, students remember how to read words by drawing on their partial alphabetic connections, particularly capturing the initial and final sounds of words (Ehri & Wilce, 1987; Spear-Swerling & Sternberg, 1994). Phonological factors play a crucial role in this (Frith, 1985) and students are most likely to recognise a word when its spelling is phonetically close to the actual letter sounds (Ehri & Wilce, 1985). For beginning readers, learning and applying the grapho-phonic connection to the reading process is a major step forward and a prerequisite to reading fluently in the future (Stanovich, 1986). For readers with an intellectual disability, such as those in this study, it is a particularly significant achievement (Snow et al., 1998).

The students' growing alphabetic knowledge is also reflected in their writing attempts, where the letters function as symbols for sounds, particularly those sounds which have a direct grapheme-phoneme correspondence. Letter order and phonological factors play a crucial role (Frith, 1985) and partial alphabetic readers can process cvc (consonant vowel consonant) and cvcc (consonant vowel consonant consonant) words more easily than ccvc (consonant consonant vowel consonant) words, drawing on the phonetic cues they have learnt (Ehri & Wilce, 1987). It is also likely that attempts in both writing and reading, do not result in a consistent left to right pattern as this skill is still developing, often resulting in words being read or written back to front (Ehri & McCormick, 1998).

To take advantage of the students' growing phonemic awareness, teachers must begin to teach the skills of blending and rhyming (Spear-Swerling & Sternberg, 1994), segmenting words into their constituent sounds (Fowler, Liberman, & Shankweiler, 1977), and sounding out (Ehri & Wilce, 1985). Students in this phase have difficulty in applying decoding strategies for reading unfamiliar words and new words are often misread due to the partial resemblance to letters within known words, for example sit and site (Ehri & McCormick, 1998).

To move into the next phase, explicit instruction should be aimed at expanding working knowledge of grapheme-phoneme relations using reading and writing activities to help build a sight word vocabulary (Ehri & McCormick, 1998).

The following section summarises some of the teaching activities that are relevant to the students participating in this study, focussing on the partial alphabetic phase of reading.

Teaching Activities

This morning, ABC Kids changed their television programming. 'Bananas in Pyjamas' has been replaced with 'Fireman Sam'. Chaos is now guaranteed, the morning routine has changed without notice, and Marcus is unable to proceed with breakfast, dressing, or any other usual task that facilitates getting ready for school. Marcus is finally coerced into the car and arrives late – another routine upset as he has now missed out on his usual settling time and is launched straight into the more formal aspect of the school day. His ensuing behaviour upsets the rest of the class and they engage in negative behaviours such as tantrums and self-abuse. There is a need for the teacher to recognise the situational, social and emotional attributes of all the students in designing and implementing the teaching program, so after a short abandonment of the daily routine, a quick play followed by a session on recognising and dealing with emotions, a phonics lesson is required! How should that lesson be implemented?

(Personal anecdote)

The Australian Government's National Inquiry into the Teaching of Literacy (Department of Education, 2005) *Teaching Reading*, concluded that the Whole Language approach to the teaching of reading, where the emphasis is upon meaning-based reading and writing activities, is not in the best interests of students, especially those students who are having difficulty in learning to read. Rather, students need to acquire the basic building blocks for reading, including grapheme knowledge (names and sounds), phonological awareness (explicit knowledge of the sounds of language), how words are composed of these sounds (Coltheart & Prior, 2007, p. 4) and a grasp of the alphabetic principle (that individual sounds of language can be represented by individual symbols on a page – graphemes). According to this latter view, extensive, systematic, explicit instruction in phonics needs to be included in the first two or three years of schooling for a reading program to be effective (Coltheart & Prior, 2007; Department of Education, 2005).

The conclusion to the literature review in the *Teaching Reading* report is consistent with the findings in the literature reviews conducted by the USA National Reading Panel (2000) and that of Rose (2006) for the UK Government; systematic and explicit instruction in phonics is an essential component of any effective reading program and can be used with students with intellectual disabilities (Saunders, 2007). A systematic and explicit phonics approach offers many students the best and most direct route to becoming skilled readers and writers. Systematic and explicit phonics' work is essential for the development of reading, writing, and especially spelling (National Reading Panel, 2000; Rose, 2006) and delays in the acquisition of phonic skills have a multiplying, long-term negative effect on reading achievement (Stanovich, 1986).

A systematic and explicit program teaches students directly and overtly the relationships between graphemes and phonemes in a clearly defined sequence, and how to apply them when decoding unfamiliar words by sounding out the individual graphemes and blending them (Ehri, 2004; Ehri, Nunes, Stahl, & Willows, 2001). The teaching of phonics systematically includes short and long vowels and vowel and consonant digraphs consisting of two letters representing one phoneme (Ehri, 2004). Activities should encourage interaction among students and the teacher, support the students' curiosity about language and their experimentation with it and ensure that individual student differences are identified, prepared for and allowed. Activities that help to develop the students' interest in literacy and a positive attitude include the sharing of favourite books, providing opportunities to participate in socio-dramatic play, songs and rhymes and encouraging talk about students' experiences and responses in relation to the stories or activities (Rose, 2006). Teaching strategies should include introducing small steps or components at a time, allowing students time to practice each step, and guiding students during initial practice while providing many opportunities for success (Rosenshine & Stevens, 1986). A systematic and explicit instructional approach using these procedures formed the basis of instruction for this research project.

Snow et al., (1998) analysed activities and materials for supporting appropriate phonemic awareness with beginning readers and proposed a range of activities that would provide such support. Activities relating to the Partial Alphabetic Phase of reading will form the basis of the teaching program in this research, particularly those related to directing students' attention to recognising the sound and shape of letters of the alphabet and explicit instruction and practice with sound structures that will lead to grapho-phonic awareness. Examples of these activities are presented in Table 2-1.

Table 2-1
Partial Alphabetic Phase Activities

Partial Alphabetic Phase Activities
• Print-directed activities for establishing the student's ability to recognise and write the letters of the alphabet. • Oral language activities for fostering growth in listening and speaking skills and verbal reasoning. • Reading and book exploration by students for the development of print concepts and basic reading knowledge and process. • Thematic activities (e.g. sociodramatic play) for giving students opportunity to integrate and extend their understanding of stories. • Reading aloud with students to foster their appreciation and comprehension of text and literary language. • Writing activities for developing the student's personal appreciation of the communicative dimensions of print. • Explicit instruction and practice with sound structures that lead to phonological awareness. • Familiarity with spelling-sound correspondences and common spelling, and their use in identifying printed words. • Writing activities to reinforce grapheme-phoneme relations and growing knowledge of spelling and reading skills. • Word-directed activities for helping students to understand and appreciate the alphabetic principle. • Sight recognition of frequently used words. • Independent reading, including reading aloud.

(Center, 2005; Ehri & McCormick, 1998; Snow et al., 1998)

Intellectual disability

Intellectual disability is a developmental disorder characterised by significant limitations in both intellectual functioning and adaptive behaviour. Intellectual functioning refers to an individual's general mental capacity for learning, reasoning, problem solving, understanding concepts, concentrating and remembering. For students with intellectual disabilities adaptive behaviour is seen as being comprised of three skills: conceptual skills or those related to language and literacy, money, time and number concepts, and self-direction; social skills, related to interpersonal skills, social responsibility, and self-esteem; and, practical skills related to daily living, occupation and healthcare (American Association on Intellectual and Developmental Disabilities, 2013; Department for Communities and Social Inclusion, 2014). Individuals with intellectual disability also possess strengths and, for example, with appropriate support are capable of learning. This is considerably so when instruction is adapted to meet the student's particular needs (Copeland, 2007; Taylor, Sternberg, & Richards, 1995).

Students with intellectual disability appear to be much less mature than their age peers, and their behaviour patterns, skills and general knowledge are related more closely to their mental age. Students with intellectual disability typically find the cognitive and metacognitive components of learning, such as interpreting information, reasoning, monitoring and problem solving, very difficult processes. However, by teachers drawing on personal experiences and situations that students with intellectual disability can directly relate to, the students' capacity to build vocabulary and language comprehension increases and in turn helps students to understand and remember with greater reliability is heightened (Westwood, 2004).

Students with intellectual disability can learn to identify sight words in isolation (Browder & Xin, 1998). However, a problem with this approach is that often the development of other skills that partial alphabetic readers would apply to reading and writing, such as grapho-phonemic knowledge, remain underdeveloped (Erickson, Hatch, & Clendon, 2010). More recently, research has shown that students with intellectual disability, when explicitly and systematically taught early reading skills such as phonological awareness skills, can successfully learn the separate skills such as sounding and blending; and use grapho-phonemic knowledge to decipher unfamiliar words (Allor, Mathes, Champlin, & Cheatham, 2009; Allor, Mathes, Jones, Champlin, & Cheatham, 2010; Browder, Ahlgrim-Delzell, Flowers, & Baker, 2012; Browder, Ahlgrim-Delzell, Courtade, Gibbs, & Flowers, 2008). Furthermore, the development of vocabulary and oral language comprehension is paramount when working with students with intellectual disability, thereby supporting the approach undertaken in this thesis.

The students who participated in this research project had mild to moderate intellectual disability and displayed significant attentional and memory problems combined with language difficulties or disorders. Therefore, it was necessary to use strategies that helped the students to attend and maintain their attention to the task, as well as explicit instruction in an aspect of phonological awareness to develop their reading decoding skills. This research supported the need to provide learning opportunities that were related to the student's own experiences and knowledge, and the need to give both visual and aural inputs.

Teaching that incorporated a multisensory approach and multimedia have been shown to help students with learning disabilities assimilate and remember particular units such grapheme-phoneme correspondences and sight words, possibly because the incorporation of sound, vision and movement help to draw attention to the learning task (Westwood, 2007). This cognitive approach to teaching and learning will now be addressed.

Cognitive Theories and Their Impact on Instructional Design

A cognitive analysis of learning seeks to understand how incoming information is processed and structured in memory and how it is used in problem solving. In the classroom, student learning is influenced by the teaching strategies employed by the teacher, and by the learning strategies activated by the learner to select, organise and integrate new knowledge into their existing knowledge. Cognitive theories of learning put the focus of cognitive-related activities on both the teacher and the student (Weinstein & Mayer, 1986).

The teacher is responsible for providing positive learning environments that encourage a sense of belonging and help the student to engage with the material being presented (Fredericks et al., 2004). The pace, volume and method of delivery of material presented also needs to be regulated to ensure that students do not become overloaded and are able to select what is relevant in the learning situation (Rosenshine & Stevens, 1986).

For students, the ability to select, assimilate, memorise and systematically store information has an enormous impact on developing both their receptive and expressive language skill capabilities (Dehaney, 2000). Lawson's (2008) COATSRUAM Framework (Figure 2-1) provided a conceptual framework for the information processing events which underpinned this research project.

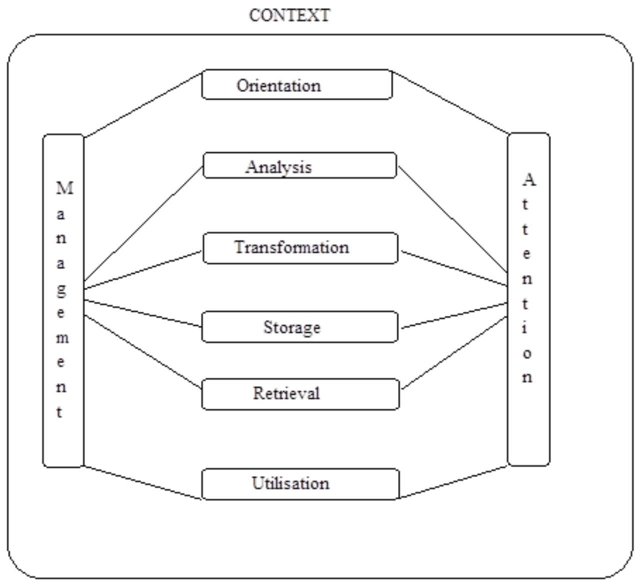


Figure 2-1
Lawson's (2008) COATSRUAM framework

Context

The students' ability to learn, recall and successfully apply the learned material is affected by situational, social and environmental cues such as school and home related events (Sturomski, 1997). For students with intellectual disabilities, these stressors can be as simple as a change of routine either at home or school, or can be more problematic, such as medication not being administered or being a victim of bullying at school. These stressors can interfere with learning, however, with teacher guidance, more adaptable behaviours can be taught and activated such as seeking social support or problem solving (Boekaerts & Corno, 2005).

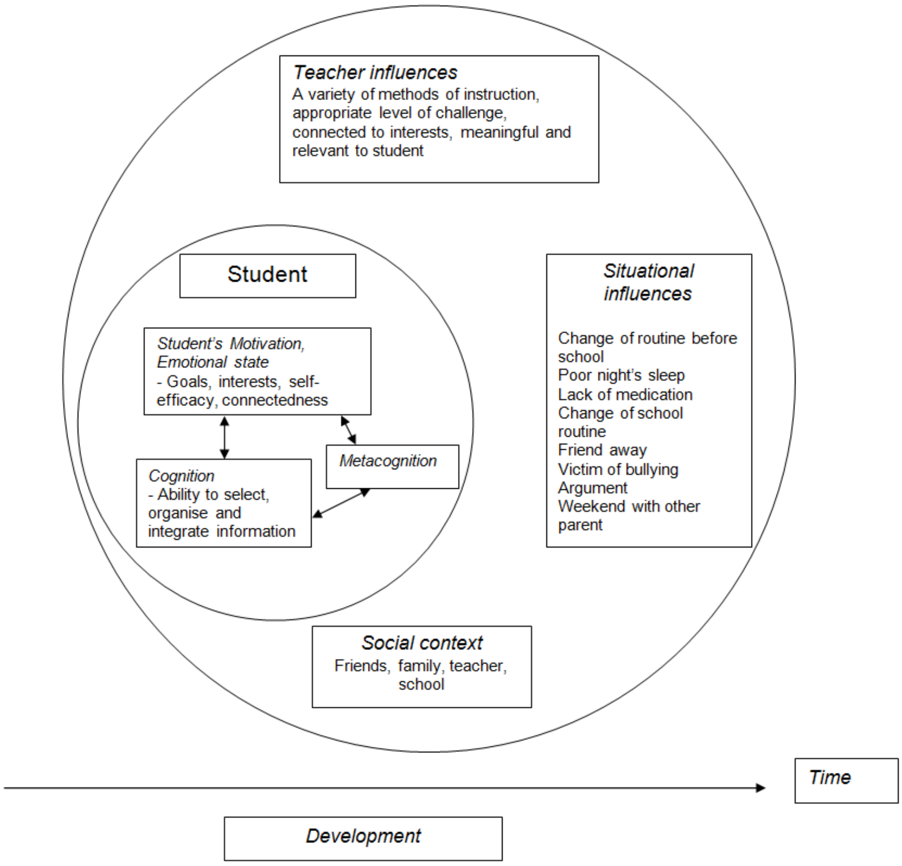


Figure 2-2
Contexts which influence student behaviour and learning

Figure 2-2 depicts the type of influences a student may encounter which have an impact on their behaviour and learning opportunities at school. The teacher yields much control over the student and school related events. Therefore, it is important for the teacher to explicitly plan instruction so that it builds connections between what the students already know or have experienced with the key ideas they are trying to teach (Lawson, 2008; Westwood, 2004), matching the students level of readiness to access the tasks and participate in the learning activities while developing and applying explicitly taught cognitive strategies (Jarvis, 2011).

Orientation

Engagement (discussed more fully in the next section), with the learning materials being presented may be induced by promoting social-emotional goals, so that a sense of emotional engagement or orientation is established between the student, their peers and/or their teachers and the task (Fredericks et al., 2004; Schunk & Zimmerman, 1997). In addition, students need to self-regulate their learning behaviour and be able to effectively apply their thoughts, feelings and actions to their learning, and therefore be actively engaged in a suitable motivational state as they transform information into knowledge (Boekaerts & Corno, 2005; Schunk & Zimmerman, 1998; Winne, 2005). The social-emotional and motivational elements involved in learning form a key part of the broader self-regulatory view of learning in which students are able to direct their learning towards a goal while being selective in relating to what they already knew, organising their knowledge and ultimately, reflecting on their knowledge and actions to achieve positive academic outcomes (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Lawson & Askell-Williams, 2011).

The students in this research project find it difficult to focus for long periods and can be expected to experience difficulties in many of these areas of self-regulation, both social-emotional and cognitive. This suggested that it will be important to teach self-regulation strategies via explicit, direct instruction whilst emphasising the relevancy of the lessons to keep the student's attention oriented towards the learning tasks (Schunk, 2001; Sousa, 2007; Sturomski, 1997). A positive relationship between the researcher and students was encouraged to help promote the social-emotional aspects of learning and engagement, introducing tasks that were challenging yet aimed at their particular ability levels (Elias, 2006). Strategies such as orienting, focussing, asking questions, checking, re-reading text when it does not make sense, risk taking and drawing pictures to help cue writing tasks (Westwood, 2004), were taught to the students by drawing their attention to the researcher modelling the use of the strategies, by providing explicit, task oriented feedback and allowing students the time for practice and rehearsal to help develop self-regulatory behaviours.

Analysis

The presentation of information was in small segments to allow students processing time to analyse and select information being presented in the task or problem. A check on students' existing knowledge prior to the commencement of the lesson helped to establish an initial understanding of the task (Lawson, 2008). This also enabled instruction to be directed to the students' specific area of need, whilst ensuring that the teacher could provide the necessary background details such as the names of grapho-phonemes and their relevance to the ensuing lessons, or orienting the students' attention to what was being taught (Mayer & Moreno, 2003). This approach supports students with intellectual disability and their learning (Westwood, 2004).

Transformation

To establish a context in which learning can occur, Mayer and Moreno (2003) recommend that instruction be designed to minimise the strain put on the student's working memory (cognitive load) and should include a multimedia presentation. A multimedia instructional message, as defined by Mayer (2005a, 2005b) is a communication intended to foster learning that contains both words and pictures. The interaction between sound, the written word and images of objects presented is considered to enhance the elaboration, transformation and organisation of information into long term memory. In terms of vocabulary learning, research shows there is improved learning for those words coded visually and verbally, compared to words only coded verbally (Mayer, 2001; Plass, Chun, Mayer, & Leutner, 1998, 2003). Students with intellectual disability are generally better learners when material is presented visually, therefore co-presenting material to be learnt visually and verbally will strengthen students learning opportunities (Rosenquist, Conners, & Roskos-Ewoldsen, 2003).

However, simply adding pictures to words does not guarantee improved learning outcomes (Mayer, 2005b; Sakar & Ercetin, 2005; Seufert, 2003) and may even hinder learning if the connections, or transformations, between the verbal and visual representation of ideas cannot be made, or too much visual/verbal information is presented (Plass et al., 2003). To help maximise the effectiveness of picture-word matching, students will be required to pair words (nouns) and pictures to encourage active participation (Fossett & Mirenda, 2006) and to help promote vocabulary comprehension, building connections with the students personal experiences (Erickson et al., 2010).

Verbal elaborations, a process of transforming new information into memory through the student explicitly connecting the strategy or activity to their experiences and knowledge were encouraged by the researcher, using prompting and questioning to guide problem solving attempts (Ankrum, Genest, & Belcastro, 2014). This support to students was developmentally appropriate as it encouraged students to think at a more meaningful level (Maloch, 2002). Furthermore, research by Ornstein, Haden and Hedrick (2004) indicated that young students and pre-school children's memory is developed through elaborative joint discussions, where participating in conversations about past experiences provides opportunities for students to gain experience in the retrieval of information in response to explicit probes.

The students were also allowed time to transform the knowledge of information through rehearsal and tasks that repeated the reading skill of focus (Lawson, 2008). Reading strategies were taught to help develop understanding of decoding words through sounding and blending.

Storage and Retrieval

The organisation and integration of the pictorial and verbal representations with relevant existing knowledge into long term memory is important. The visual and verbal inputs provide the possibility of a dual representation network for the idea or procedure being presented (Baddeley, 1997; Paivio, 1971). The students' prior knowledge is also integrated into the organisation and storage of the dual representation to build schematic networks that develop to enable faster processing and retrieval of relevant, related information (Jonassen, Beissner, & Yacci, 2010; Schneider, 2015).

When students are given sufficient practice, schemas can become automated and used without conscious control (Kalyuga, 2011), a desired outcome for the process and application of reading skills. The prior knowledge brought to a learning situation influences learning when constructing or modifying knowledge in long term memory (Kalyuga, 2012). The more senses engaged in receiving information (saying, seeing, hearing and doing), the more accurate the representation of the stored memory which leads to a greater recall of details (Scruggs & Mastropieri, 1990).

Students with intellectual disability have been shown to have trouble rehearsing verbal information to facilitate the storage of information into long term memory, but have less difficulty storing and retrieving visual information (Rosenquist et al., 2003).

Utilisation

The transfer or the utilisation of stored knowledge during problem solving is the ultimate goal of instruction, and indicates that the students have successfully selected, organised and integrated the information presented and been able to retrieve relevant knowledge to apply the information to a novel problem-solving situation (Bransford, Brown, & Cocking, 2000). The students were presented with problems to solve in each lesson based on the phonemic awareness skill of focus.

Attention

The final boxes in Figure 2-1 refer to attention and management (Lawson, 2008). Attention is represented here as a limited, allocatable mental resource (Anderson, 2010). Instructional design must gain and direct student attention toward activities that are relevant to learning (Westwood, 2004), taking into account limits on attention and cognitive load, and reducing extraneous information which may interfere with the learning process (Chandler & Sweller, 1991; Sweller, 2004, 2006). As the teacher, it is important to be aware of students' limitations and the potential cognitive load problems instructional techniques can impose on the learning process

(Sweller, 2004, 2006). Tasks should be established that do not divide the student's attention within tasks and should scaffold the students towards achieving the learning goal with the guidance of the teacher or more capable peers (Vygotsky, 1978).

Cognitive load considerations are particularly relevant to novices and students with special educational needs. To maximise learning opportunities, cognitive load associated with the manner in which instruction is designed (Sweller, 2010) needs to be minimised by using direct, explicit instruction, building in small, cumulative steps and drawing on existing knowledge. Students or learners should have clear expectations of what they are learning and why, they should never be required to discover the reason for doing something when teachers can directly communicate this to them (Sweller, 2006).

The systematic, explicit delivery of the phonemic instruction is also relevant here, as the instruction was tailored to the individual student's needs, incorporating only the necessary visual and auditory information required to teach the target skill, thereby reducing extraneous cognitive load. Tailoring the instruction to the student's needs has been shown to be advantageous (Allor et al., 2010).

Management

Management, or regulation, of the students learning is done through the metacognitive strategies that are utilised by the students to plan, monitor and reflect on their learning (Zimmerman, 1990). This component is further elaborated in the Engagement (cognitive) section of this paper.

Multimedia, Cognitive Load and Interactive Whiteboards

Multimedia is referred to by many researchers as simply the use of current technologies. This form of multimedia sits comfortably with today's students as many have been connected with technology in some form since birth (Tileston, 2004). However, Mayer (2005a) has defined multimedia as presenting both words and pictures together. Words could be presented in either spoken or written form while pictures could be presented as either fixed or animated. More importantly, Mayer goes on to describe that multimedia learning occurs when multimedia presentations help students to build knowledge through building mental representations.

The Interactive Whiteboard (IWB) is able to incorporate current technology and Theory Of Multimedia Learning with ease, appealing to student's dominant senses of seeing, hearing and touching (BECTA, 2003; Tileston, 2004). However, as with all teaching, the IWB can also be used in a way that provides too much information, overloading the limited working memory of students by providing interesting but extraneous or irrelevant information (Mayer, 2001; Plass et al., 2003; Sakar & Ercetin, 2005). These extraneous details are also known as bewitching details that are memorable, but offer little to deepen the students understanding of the concepts being presented as they distract students' attention from the key instructional concepts (Harp & Mayer, 1998; Lehman, Schraw, McCrudden, & Hartley, 2007).

Therefore, IWB/multimedia instruction needs to incorporate three cognitive science principles of learning as identified by Mayer (Mayer, 2001, 2003, 2005a, 2005b) in his Cognitive Theory of Multimedia Learning to maximise the potential of the students achieving the learning outcomes (Cutrim Schmid, 2008).

1. The human information processing system includes dual channels for visual/pictorial and auditory/verbal processing (Baddeley, 1997; Paivio, 1971). Therefore, all lessons included both aural and visual components as Mayer (2001) argues a higher quality and quantity of learning is achieved when both text and pictures are presented.

2. Each channel has limited capacity for processing information, a central feature of Chandler and Sweller (1991) and Sweller's (1999, 2004, 2006) Cognitive Load Theory. Instruction was restricted to teaching only the phonemic awareness skill of sounding and blending OR letter/sound correspondence. One new rime or letter was introduced at any one time. The focus of sound/blending or letter/sound correspondence was dependent upon the skill of focus for the student. The introduction of novel activities was restricted to being introduced after the presentation of a new rime or letter.

3. Active, meaningful learning entails carrying out a coordinated set of cognitive processes during learning. The cognitive process that need to be coordinated were selecting (analysing), the relevant words or images from the presented information, transforming and organising the selected words or images into a coherent representation and integrating (store) the pictorial and verbal representations with existing knowledge. The lessons, drawing on the principles of Multimedia learning were designed to prime these processes which were central to active learning (Mayer, 2001, 2005a, 2005b; Mayer & Moreno, 2003)

In the next section, the construct of Student Engagement in learning will be introduced and its relationship to learning and improved academic outcomes will be described. There are three core areas of student engagement in learning: cognitive engagement draws on the cognitive aspects of self-regulation described in this section, behavioural engagement is related to the actions performed during a task, and emotional engagement is associated with the sense of belonging and the student's affective state whilst at school and during the task.

Engagement

Student effort, interest and the application of learning strategies towards learning tasks is required for learning to take place. This is referred to as student engagement, and is positively associated with academic outcomes (Fredericks et al., 2003). Student engagement in learning is defined as students' participatory, cognitive, and affective/emotional behaviours towards instructional activities or tasks with their teachers and classmates (Lutz, Guthrie, & Davis, 2006). Therefore, it is important to measure the level of student engagement in learning tasks to test whether or not there is a correlation between the levels of engagement and the rate of learning.

Behavioural engagement is exhibited in such things as student attendance and active participation in the learning task, and is considered crucial for achieving improved academic outcomes (Fredericks et al., 2004). Behavioural engagement can be observed by watching students participate in class and school activities, completing their work and following the rules. Students with a high level of behavioural engagement invest effort into the learning tasks, while displaying persistence and concentration (Fredericks et al., 2004; Peterson, Swing, Stark, & Waas, 1984; Russell, Ainley, & Frydenberg, 2005; Skinner & Belmont, 1993).

Emotional engagement refers to a sense of belonging, a student's positive or negative reaction to teachers, classmates, academics and school, and is associated with a willingness to participate in classroom tasks. Emotional engagement can be observed by witnessing students' affective reactions in the classroom, including levels of interest, boredom, happiness, sadness, and anxiety (Connell & Wellborn, 1991; Skinner & Belmont, 1993). Some researchers also assess emotional engagement by measuring students' emotional reactions to the school and the teacher (Fredericks et al., 2004; Russell et al., 2005). Lutz et al., (2006) renamed the observational characteristics of emotional engagement as affective engagement, as this term implies more strongly the physical display of emotion. This research project will also use the term affective engagement as it will rely on the physical display of emotion to indicate the student's level of engagement in this dimension.

Finally, cognitive engagement is expressed as an investment in learning, engaging in activities necessary to comprehend complex ideas and skills and self-regulating performance in order to achieve set goals (Fredericks et al., 2004; Furlong & Christenson, 2008). Cognitive engagement describes a student's inner quality of concentration and effort to learn, the psychological effort directed toward mastering knowledge, skills or crafts that is more than just behavioural engagement (Newmann, Wehlage, & Lamborn, 1992). Whether described as cognitively engaged or self-regulated, strategic students use management (metacognitive) strategies to plan, self-monitor and self-evaluate their cognition when accomplishing tasks (Zimmerman, 1990). Students with high levels of cognitive engagement use learning strategies such as rehearsal, summarising and elaboration to select, remember, organise and understand the material (Winne, 1996). As discussed previously, students with intellectual disability find cognitive and metacognitive processes difficult, however the researcher will attempt to develop and build these strategies by drawing on the student's prior knowledge and experiences and linking them to the lessons being taught (Westwood, 2004).

Engagement theory fits in the COATSRUAM framework (Lawson, 2008) under the headings of orientation (effort and interest), utilisation (application of learning strategies) and management (metacognition).

Engagement is a key focus of this study.

Measuring engagement

Student behavioural, cognitive and emotional engagement has been measured via observation, interview, teacher report and self-report (Dunlap, 1984; Dunlap & Koegel, 1980; Fredericks et al., 2003; Laevers, 1994; Lutz et al., 2006; Skinner, Kindermann, & Furrer, 2009). For example, Fredericks et al., (2003) developed a child survey administered to students across a three year period; teacher surveys were also completed each year in regards to the students' behavioural, emotional and cognitive indicators of engagement. Furthermore, a subset of students was interviewed in an effort to examine differences in how students talked about their classrooms, schools, work, teachers and peers. Skinner, Kindermann and Furrer (2009) also used self-report and teacher reports on student engagement during a four-year longitudinal study on student motivation and engagement in school. Their study also included observations of student engagement and disaffection in the classroom, relying on video footage which was later analysed. Lutz, Guthrie and Davis (2006) used 30 second observation intervals to identify student engagement across three, year 4 classes.

When working with students with intellectual disability, observational techniques are preferred, due to participants often being unable to process verbal commands or questions, or to read and comprehend written questions. Young students typically also have difficulty with reflecting upon their thinking, an aspect compounded by an Intellectual Disability (Fredericks et al., 2003). A number of researchers have developed different observational instruments for measuring engagement and these were drawn upon in designing the observational framework for this study.

Koegel and Egel (1979), Dunlap and Koegel (1980) and Dunlap (1984) developed an observational checklist (Rating Scales for Child Affect) based on behaviour, emotion and cognitive participation in tasks by participants with Autism Spectrum Disorder or learning disabilities. The Enthusiasm and General Behaviour Scale (Dunlap, 1984; Dunlap & Koegel, 1980; Koegel & Egel, 1979) reflects behavioural responses such as performing the task (or not), engagement with the materials or researcher between trials, and being attentive. Fredericks et al., (2004) and Furlong & Christenson (2008) also identified that behavioural engagement can be readily observed by watching students participate, complete work and follow rules. Further to this, Lutz et al., (2006) observed students' body language, such as yawning and posture to indicate the level of behavioural engagement, a concept also used by Laevers in the Leuven Involvement Scale for Young Children (Laevers, 1994). Cooper and Brna (2002) looked at task related behaviour, but were also able to support their observations with interviews with the students. Finn (1989, 1993) focused primarily on the behavioural dimension of participation. In the early school years, Finn identified participation as attending, being prepared and responding to directions or questions initiated by the teacher, stating that '*even this … participation may be resisted by some'* (p 6, 1993). Participation was further identified by Finn, as the student initiating questions and dialogue with the teacher, and displaying enthusiasm.

Students' emotional engagement is reflected in the Interest and Happiness scale (Dunlap, 1984; Dunlap & Koegel, 1980; Koegel & Egel, 1979) and Lutz et al., (2006) affective engagement scale, indicating whether students were bored or curious, alert and attempting the task, sad or happy. Similar approaches have been used by other researchers (see Connell & Wellborn, 1991; Fredericks et al., 2003; Gillen, Littleton, Twiner, Staarman, & Mercer, 2008; Haldane, 2007; Skinner & Belmont, 1993) whereby they have observed students facial expressions for positive or negative emotions, whether students indicate delight and excitement or if they are working hard to solve problems.

Cognitive engagement is more difficult to observe and is not assessed in the Rating Scales for Child Affect, although Lutz et al., (2006) attempted to identify a set of observable behaviours that reflected cognitive engagement. However, Chi and Wylie (2014) refer to the way in which a student engages with the learning materials in the context of an instructional or learning task, is reflected in the overt behaviour the student voluntarily exhibits while undertaking an activity, such as summarising or participating in a dialogue with another person while constructing knowledge (p. 219). Many of the overt constructs for cognitive engagement identified also appeared across the other areas of engagement. Lee and Anderson (1993) identified observable cognitive strategies primarily through use of linguistic indicators such as students integrating new knowledge with existing personal knowledge, requesting clarification or the use of analogies. Helme & Clarke (2001) also identified the use of verbal indicators as cognitive engagement such as verbalisation of thinking, asking of questions, the exchanging of ideas and justifying answers. Mayer (2001) reviewed video footage of students participating in lessons as part of a pilot project, and identified cognitive engagement behaviours were related to the student performing a goal oriented activity combined with verbal indicators.

Drawing on the work of the above authors, an observational checklist was created for this study and trialled with students completing tasks during lesson time (see Appendix A).

Student engagement rating scale (SERS) categories

The SERS observational checklist was broken down into three categories of observable student engagement: Task, affective and cognitive behavioural engagement. They will each be described below.

Task engagement behaviours focused on two behaviours a student would display if actively engaged, such as time on task and whether the student was reluctantly complying with instructions or performing the task quickly and without interruption. The students' eye contact with the task or the teacher was also observed in this construct and whether or not they were watching the teacher or task throughout the observation period.

Affective engagement behaviours included in the SERS comprised the observable behaviours of whether students were showing an interest in the task presented, whether they were showing indicators of enjoying themselves and showing emotion through their facial expressions and whether they continued or persisted with the presented task once faced with a problem or if they perceived they had made an error.

Cognitive engagement behaviours focused on four observable behaviours: selection, elaboration, monitoring and problem solving. Selection identified whether the student could choose the appropriate elements of a task or choose appropriate materials for a task. Elaboration behaviours aimed to identify any verbal or non-verbal responses that showed the student connecting material to anything they already knew, or that involved some addition to information being presented in the lesson. Adding to the task would include behaviours such as creating new, non-presented words, extending upon an idea and recalling relevant words. The element of monitoring looked at whether the student was able to recognise an error and self-correct or ask questions related to the task to clarify. Finally, the problem solving element scaled the student's performance in terms of accuracy when a problem situation was presented, being a situation where the student needed to retrieve and apply newly learned knowledge.

The following section introduces the Interactive Whiteboard and its usefulness as a teaching tool, to engage students in the learning process, challenges faced and how the IWB can benefit teaching students with intellectual disability. The application of ICT to teaching has provided new opportunities for students by enabling active, flexible and highly individualised learning experiences. These new learning environments are often intrinsically motivating and can engage students after the initial novelty reaction has worn off (Russell et al., 2005).

Interactive Whiteboards (IWB)

What is an Interactive Whiteboard?

An interactive whiteboard (IWB) is a large, touch-sensitive board connected to a digital projector and a computer. The computer images are displayed on the board by the projector where they can be manipulated. The software can be controlled from the computer or by touching the board, either directly by hand or with a special pen (BECTA, 2003; Bell, 2002).

The design of research investigating the use and impact of IWBs in classroom environments varies across subject areas (Gillen et al., 2008; for examples see Glover et al., 2005; Shenton & Pagett, 2007), and often involve the gathering of the perceptions of teachers and students in the form of interviews, surveys and questionnaires (Glover, Miller, Averis, & Door, 2007; for examples see Hall & Higgins, 2005; Smith et al., 2005; Wall et al., 2005). Some of the research on the use of IWBs offers conflicting outcomes. While much of it supports the notion that the introduction of IWBs into classrooms leads to improved pedagogy and student outcomes (BECTA, 2003), other research casts doubts over some of these claims (Higgins, 2010; Moss et al., 2007; Tanner & Jones, 2007). This section will consider four sets of claims made in the literature:

(i) claims with a general focus;

(ii) claims with a teaching and learning focus;

(iii) challenges associated with the use of IWBs; and finally

(iv) the use of IWBs with students with special needs.

Why use an Interactive Whiteboard?

The literature associated with the use of IWBs often contains a set of general claims about the advantages of IWB use. Broadly, the purpose for using IWBs in the classroom is to enable access to and use of digital resources for the benefit of the whole class, while preserving the role of the teacher in guiding and monitoring learning (Gillen, Staarman, Littleton, Mercer, & Twiner, 2007; Hall & Higgins, 2005). For the teacher, the IWB allows flexibility by enabling material to be pre-prepared or created on the spot that can be quickly retrieved for display to the whole class when required and manipulated directly on this display (Kennewell & Beauchamp, 2007; Kennewell, Tanner, Jones, & Beauchamp, 2008). Interactive lessons that are planned in advance to support learning, can underpin lesson structure to enhance the way in which students think through a clear visual representation of concepts (Glover et al., 2007). A teacher can use the IWB to produce quite complex and interactive lessons more easily than previously possible, providing a clear structure for a well-resourced lesson whilst retaining the capacity for spontaneity or provisional adaptation of the lesson as it proceeds (Gillen et al., 2007). Through the IWB teachers can access the internet to educational websites, video and audio clips, photos and textual material to enrich their teaching (Coyle, Yan, & Verdu, 2010)

The IWB also provides the capacity for student interaction with, and control of, the display. It is suggested that an important feature of the teaching style that is evolving with use of IWBs, is its similarity to the multimedia, multi-sensory, multifaceted style the students experience with their computer games and television, thereby providing a link to what the students know and enjoy doing (Lee & Boyle, 2003; Slay, Sieborger, & Hodgkinson-Williams, 2008; Tanner & Jones, 2007). The multimedia, multisensory features of IWBs are claimed to enhance students' memory as information can be presented in colour; can be concealed, manipulated (physically and electronically), information can be moved and zoomed in on or have a focus on images; IWBs have the ability to provide audio support and enable hyperlinks and other media to be embedded into lessons (Smith et al., 2005). The board can accommodate auditory, visual and kinaesthetic learning channels as learners benefit from touching and marking the board, participate in class discussions, listen to pre-recorded input, and see what is taking place as it develops at the board (Bell, 2002). It is these features that have the ability to *'intensify learners' participation in, and amplify the* *importance of, the activity'* (Jones, Kervin, & McIntosh, 2011, p. 58). Possibly, the most important reason to incorporate lessons conducted on the IWB is the perception by both teachers and students of the perceived improvement in teaching and learning (Higgins, 2010) in the lessons in which IWBs are used.

The IWB also appears to have significant potential to provide an effective medium of instruction for students with intellectual abilities. The dynamic and graphical capabilities of the IWB are predicted to offer substantial advantages for presentation of curriculum content in ways that students with intellectually disability can interact with, and also manipulate. If these expectations can be realised they can provide an important complement to other instructional approaches being used with this group of students (Martin, 2007; Somekh et al., 2007). Whitby, Leininger and Grillo (2012) also highlighted the visual processing strengths many students with intellectual disability have and the IWB can provide a medium in which the information can be paired both visually and verbally which may lead to increased understanding. The visual supports help to develop students' receptive language capabilities (Pennington, 2010) by providing concrete visual examples of abstract concepts and allowing the consistent representation of an activity or model, allowing for much needed repetition (Goldsmith & LeBlanc, 2004).

At the time of writing, there was little detailed empirical research on the benefits of the use of IWBs, particularly in the area of students under eight years of age (Burnett, 2010) or students with intellectual disabilities. Smith, Higgins, Wall and Miller (2005) identified in their literature review on IWBs, the need to undertake research to fully understand the impact of IWB technology on teaching practice and student learning as they could not find any experimental research to review. The longitudinal data gathered from mainstream schools following the UK government initiatives in provision of IWBs suggests, that after the initial improvement in perceived performance outcomes in English, Mathematics and Science, the students tend to revert back to previous levels in subsequent years (Bahadur & Oogarah, 2013; Glover et al., 2005; Higgins, 2010; Higgins et al., 2005; Moss et al., 2007; Schuck & Kearney, 2007). This evidence has been derived from student attainment data in national tests, interviews, surveys and questionnaires relating to teachers' and students' perceptions. This type of evidence is common in most of the research literature relating to the effects of IWBs.

The evaluation report by Somekh et al., (2007) used language such as positive gains are *likely* to be achieved by all attainment groups, *may* lead to a widening gap in attainment for low achieving students, and *appears* to have relatively little impact on raising the attainment of students with special needs.

This research project was designed to provide a detailed comparative study on the use of IWBs versus traditional teaching delivery with respect to teaching grapho-phonic knowledge and in particular whether IWBs have an impact on learning outcomes when used with students aged 6 – 9 years with intellectual disability.

The IWB as a teaching tool

The IWB has the potential to engage students in learning by providing a tool that is perceived by teachers and students as relevant and up-to-date (Moss et al., 2007; Tanner & Jones, 2007) by bringing improved presentation to lessons, and helping to motivate and engage students in their learning (Beeland Jnr, 2002; Miller, Averis, Door, & Glover, 2005). This is in keeping with the view that technology needs to become an integral part of most lessons, combining concept and cognitive development in a way that utilises the interactive capacity of the technology (Higgins, 2010; Miller et al., 2005; Miller, Glover, & Averis, 2004).

The National Reading Panel (2000) suggested that multimedia options, where appropriate, should be used to enhance teaching to read, while Snow et al. (1998) saw the use of ICT as promising in teaching students to read and the prevention of reading difficulties. Higgins et al, (2005) and Smith et al, (2005) identified in their literature reviews of IWB use the common themes of flexibility and versatility, multimedia/multimodal presentation, efficiency, supporting planning and the development of resources, modelling ICT skills, and interactivity and participation in classrooms. These themes will be now explored.

- **Flexibility and Versatility of the IWB.**

The functions of the IWB enable lessons to contain a range of activities that cater for students and their abilities, whether physical or cognitive (Jamerson, 2002; Lee & Boyle, 2003; Smith et al., 2005). The IWB technology offers flexibility to teachers by enabling teachers to access a range of resources on-line (Higgins, 2010). Other attributes of the IWB, such as being able to save lessons, enables students' to revisit lessons or concepts in their own time, and for teachers to revise lessons and modify/improve them (Higgins et al., 2005; Jamerson, 2002; Mercer, Hennessy, & Warwick, 2010; Smith et al., 2005). Modifications can be made to lessons as lessons unfold, and lessons can be saved for later access by students and teachers (Mercer et al., 2010; Schuck & Kearney, 2007; Smith et al., 2005). Gross, rather than fine, motor movements are required to manipulate the board enabling access to most students (Higgins et al., 2005; Lee & Boyle, 2003; Smith, 2001; Smith et al., 2005) and students can display their work to the class (Higgins, 2010).

- **Multimedia/Multimodal Presentation Capabilities of the IWB**

The ability to mix visual and aural information is argued to facilitate the learning process, enabling learners to make connections between what they see and what they hear, enhancing student recall (Bell, 2002; Smith et al., 2005).

- **Efficiency Gains**

Teachers report on efficiency gains through having one machine to do it all – activate hyperlinks, videos, maths games (see Bidaki & Mobasheri, 2013; Cogill, 2003; Smith et al., 2005). Students and families are also able to access lesson resources if they are made available online (Jamerson, 2002).

- **Planning and the Development of Resources**

The IWB enables units of work and individual lessons to be prepared and developed in advance, giving teachers the ability to incorporate a variety of media to enhance learning opportunities and engage students (Cogill, 2003; Schuck & Kearney, 2007; Smith et al., 2005). Saved lessons can also be used to assist students recall previous information before moving on to new content (Bidaki & Mobasheri, 2013).

- **Student Attention**

Incorporating an IWB into lesson delivery is perceived to motivate and engage students in the learning process. It has been reported that students believed the IWB helped them to attend to lessons more (for examples see BECTA, 2003; Cogill, 2003; Higgins et al., 2005; Smith et al., 2005). This impact on student engagement is seen to arise from factors such as the IWB being easily seen by students (Cogill, 2003), and its ability to provide colourful, and (sometimes) animated displays rather than just writing (Schuck & Kearney, 2007; Tanner & Jones, 2007). Some reports have found that students' attention spans, when using the IWB, often exceed that of what would be normally anticipated, particularly with very young students (Carter, 2002; Smith, 2001), deaf students (Carter, 2002), and those who can't read (Slay et al., 2008). The increased attentiveness of students then frees the teacher to teach and lead the class, rather than spend time on managing student behaviour.

Technology has held the promise of addressing attention issues with students with intellectual disability (Whitby et al., 2012) as it may allow students to sustain attention due to the multimodal features directing their attention to the relevant features of a lesson with embedded prompts in an activity (Goldsmith & LeBlanc, 2004), ultimately leading to a reduction in off-task behaviours in classrooms (Whitby et al., 2012).

- **ICT Skills**

A significant benefit that has been claimed to arise from the increased use of IWBs is the integration of ICT skills across the curriculum and the implicit/explicit modelling of ICT skills to students through their use (Cogill, 2003; Jamerson, 2002; Lee & Boyle, 2004; Schuck & Kearney, 2007; Smith et al., 2005). The consistent use of technology is said to particularly support students with special learning needs (Goldsmith & LeBlanc, 2004).

- **Interactivity and Participation During Lessons With The Use Of The IWB**

Other claims have been made about the impact of IWB use on student interaction within lessons. Much of the interactivity involves students manipulating or using the IWB, however, more discussion between students and teachers, and the increased use of open ended questions and probes has also been perceived (BECTA, 2003; Higgins et al., 2005; Levy, 2002). Higgins (2010) observed this to be particularly so after observing, interviewing and collecting self-report data from 100 teachers in their second year of using the IWB in teaching Mathematics and English. An embedding effect had occurred in lessons in which the IWB was used leading to more open questions being asked by the teacher, longer responses from the students and more general talk.

The IWB as a tool for student learning

The reports prepared by Higgins et al, (2005) and Smith et al, (2005) include a number of themes regarding the potential benefits to student learning when using an IWB. These included potential positive effects on motivation and affect, and the increased capabilities for multimedia and multisensory presentation. Each of these issues will be expanded upon in the next section.

- **Motivation and Affective Influence**

The BECTA (2003) report suggested that ‘*motivation is a key benefit of whiteboards. Reasons for this include their presentation capabilities and the high level of interaction that students enjoy [*through*] interacting physically with the board, manipulating images’* (p. 3). This report also suggested that having a student-work focus can lead to increased self-esteem and enjoyment. Changes in the level of engagement behaviours of students were identified in some reports, where more and relevant questions were being asked; and longer, more detailed responses were being provided by students (Higgins, 2010), there was increased verbal and physical participation (Gillen et al., 2008), and students attention was gained which ‘*helped to increase their concentration and also motivational levels’* (Cutrim Schmid, 2008, p. 1559).

- **Multimedia and Multi-Sensory Presentation Capabilities**

The IWBs ability to present information with the use of videos, voice recordings, sound effects, songs, diagrams and graphs is perceived by students as making learning easier by engaging them in the lessons (Cutrim Schmid, 2008; Hall & Higgins, 2005). This dual presentation ability of the IWB reflects the learning pathways as described by Mayer’s Multimedia Learning Theory (2005a, 2005b), presenting information targeted to students via visual/verbal learning channels.

Students with Special Educational Needs (SEN) and the Interactive Whiteboard

Very little research on the use of IWBs has been conducted involving students with intellectual disabilities (Yakubova & Taber-Doughty, 2013). However, some of the research reports have identified some potential advantages and pitfalls that can arise when using an IWB that would be applicable to students with intellectual disabilities.

In general, the predicted advantages of using an IWB with students with intellectual disability include the hands-on interaction with the software, the provision of conceptual links in the development and understanding of more abstract and complex ideas (Learning Development Centre, 2008). Further to this, Egerton, Cook and Stambolis (2009) state "*the IWB does afford students without strong verbal or literacy skills the ability to learn through non-verbal means through the presentation and manipulation of pictorial images, and similarly the opportunity to participate and to demonstrate their skills and knowledge" (*p.14). It is also argued that the 'experience' students encounter due to the highly visual format often resembling DVD's and video formats is helpful because these formats are ones to which many students with special needs particularly relate while supporting the development of attention (Jamerson, 2002; Learning Development Centre, 2008; Martin, 2007).

It is also noted that the IWB enables those students with poor fine and gross motor control skills to participate in lessons without the need to manipulate a regular mouse and keyboard, because student skills and knowledge are demonstrated with the tap, drag and drop features of the board (Learning Development Centre, 2008; Somekh et al., 2007).

Challenges when using an IWB

The introduction and use of IWBs is not without its problems. Much of the research to date identifies areas of concern for teachers and students alike which can lead to student disengagement in the learning process.

Problem areas that have been identified with the increased use of the IWB and consequential whole-class teaching approaches include the reduction in access to a differentiated curriculum to which students with special needs are entitled (Martin, 2007) supported by Somekh et al., (2007) stating "*While SEN pupils are enthusiastic about the board, it may not necessarily be assisting their learning"* (p. 79).

Students with ASD have in some instances experienced sensory overload, and those with Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder (ADD/ADHD) can often become over excited due to the many attributes of the IWB such as when the visual and sound features are over used (Jamerson, 2002; Learning Development Centre, 2008).

- **Interactivity**

Not just physical interactivity needs to occur at the board. Jones, Kervin and McIntosh (2011) argue that "*engagement in learning relies upon cognitive involvement too"* (p. 58). They continue to say that teachers have a responsibility to ensure intellectual involvement is actively integrated into lessons involving new technologies. Cognitive involvement encourages students to explore and construct knowledge about curriculum concepts.

- **Bewitching capabilities**

The over-integration or over-reliance on the technical features of the IWB can cause teachers and students to lose focus of the objective of the lesson (Armstrong et al., 2005; Cogill, 2003; de Castell & Jenson, 2004; Hodge & Anderson, 2007; Sakar & Ercetin, 2005). Cutrim Schmid (2008) identified in her research that she sometimes "*tended to use hyperlinks more as an instrument of power than as a way of encouraging learners' active participation"* (p. 1564) which does not support the active integration of student knowledge into the learning objectives of the lesson, undermining the opportunity to construct meaning knowledge (ibid.).

- **Pace of lessons**

Reliance on the technological abilities can lead to faster paced lessons, without students participating in in-depth questioning or discussion (Tanner & Jones, 2007). For some students, the fast pace of the lessons can fail to address their specific needs (Higgins, 2010). For example, those students who fall behind because they are unable to grasp the relationship between symbols and words or concepts without more individual help (Somekh et al., 2007), or if the lesson showed a lack of in-depth questioning, discussion or connection, then this might be associated with students disengaging from the learning process with a resultant fall in academic outcomes (Finn & Zimmer, 2012).

- **Presenting too much information**

Too much, extraneous information can be included in IWB presentations (Cutrim Schmid, 2008; Tanner & Jones, 2007; Wall et al., 2005) leading to cognitive overload and students being unable to discern between what is important to the learning task and what is not (Sweller, 2005). When students are faced with this situation they can become frustrated and disengaged from the learning activities, resulting in their own performance suffering due to the negative affect cognitive overload can induce (Kalyuga, 2011).

The challenges highlighted in the literature all have the ability to negatively affect student engagement in the learning process and minimising the impact of an intervention if not taken into account during the lesson planning process. Therefore, these challenges were considered in the design of the lessons prepared for both conditions in this research. The lessons were tailored to the individual student and their learning needs, and paced to ensure their understanding and participation in the lessons. Due to instruction only occurring with one student at a time, student interaction with the board was assured and cognitive involvement was encouraged through the use of questioning and presentation of problems to be solved. The amount of information contained within any one lesson was minimised to ensure that the students were able to select the required component of that particular lesson, and incorporated concrete examples to enable them to organise and integrate the information with their existing knowledge.

Engagement and IWBs

IWBs are argued to have a significant impact on primary classrooms, particularly with the teacher embedding ICT into the curriculum and as a consequence, having increased confidence in using ICT. Both student and teacher perspectives about engagement and motivation arising from IWB use include positive reports, particularly with the IWBs ability to bring real learning opportunities into the classroom in real time (Higgins et al., 2005). The increased interactivity between students and content has been associated with more open questions, longer discussions and more general classroom talk (Higgins, 2010) resulting in greater cognitive involvement in learning (Somekh et al., 2007).

The BECTA report (2003) identified the positive influence IWBs potentially had on student motivation and affect in the classroom, reducing negative behaviour (Whitby et al., 2012) by students in the class through increased self-esteem and enjoyment, while the multimedia, multi-sensory capabilities is perceived by students to make learning easier, helping to connect concrete ideas to the more abstract concepts (Cutrim Schmid, 2008; Hall & Higgins, 2005).

These perceived positive outcomes on student engagement should lead to positive academic outcomes because when students are affectively, cognitively and behaviourally engaged in school and learning they are more likely to experience success (Finn & Zimmer, 2012; Fredericks et al., 2003).

Further to this, when the challenges identified in both the mainstream literature in using the IWBs and the literature on students with special educational needs are taken into consideration during lesson planning, positive learning outcomes should be experienced by the students participating in this research project.

In summary, educators and researchers do not know the answer as to whether or not the use of IWBs increases the levels of student engagement, particularly in students below the age of 8 years and those with intellectual disability. The research identifies the potential of IWB use to improve student engagement, to increase attention in the very young and those with SEN. However, the data used to draw these conclusions is taken from national test data, interviews, surveys and questionnaires (refer to Engagement Measures p. 57) rather than explicitly focussing on overt learning behaviours of the students. These behaviours are those where students are actively converting information in their selection, elaboration and monitoring of output during problem solving attempts as identified in previously in *Measuring Engagement* (p. 28).

Therefore, this research endeavours to answer this question using a new student engagement rating scale that provides an expanded view of observable student engagement behaviours in the areas of task, affective and cognitive engagement.

3. METHOD

Selection of Participants

Prior to recruiting participants, ethics approvals were obtained from Flinders University of South Australia and the Department of Education and Children's Services (DECS)[1], as well as permission from the school principals, teachers and caregivers of the students in special class settings.

Consideration was given to the time when the intervention would take place so as not to negatively impact on other curriculum areas, the ability for students to freely withdraw consent or choose not to participate through verbal means, physical refusal or the use of coloured faces (See Appendix B). The coloured faces replicated those used in the 'Feelings Program' the students participated in during their regular curriculum. To reduce any possible harm from being withdrawn from class, students could 'bring a friend' to the sessions and in the event of students becoming distressed, the session will cease, the student(s) returned to their regular classroom and the families notified. Any information gathered in regards to another student's presence will not be identified or used in any way.

The participants were Junior Primary students, aged between 5 and 9 years, in special class settings, in suburban Adelaide, South Australia. Junior Primary special classes typically provide a small group setting for eight students with an identified intellectual disability who need extensive curriculum support. These classes are located within mainstream schools. To be eligible for special class placement, as stated in the Guidelines for

[1] DECS has since been renamed the Department for Education and Child Development (DECD) However, the DECS acronym will be used throughout the thesis as ethics approvals and disability guidelines were obtained from the original format.

Establishing or Relocating Special Statewide Options (DECS, 2008), the student must be:

- Verified as ***eligible*** for the DECS Disability Support Program, and
- have ***significant below average*** general intellectual ability, and
- have ***significant deficits in some*** adaptive skill areas, and
- require ***extensive ongoing support*** across most of the required Learning Areas to access the curriculum. It is anticipated that the student will be able to achieve modified SACSA Outcomes against the standards under the South Australian Curriculum Standards and Accountability (SACSA) Framework (Department of Education and Children's Services, 2008, p. 3)[2]

Students in special class settings come from schools across the district associated with the school where the special class is located.

Furthermore, for involvement in this research the students also needed to:

- Have attended school for at least one whole year (4 school terms)
- Be aged between 6 and 9 years
- On assessment, be unable to recognise four or more of the presented graphemes and the phonemes they represent in spoken and written form (Calder, 2000); or be unable to blend phonemes together; or recognise CVC words without picture prompts
- Have parental or carer consent to participate
- Have parents or carers provide permission to access departmental files for information on their disability

Special class teachers were asked to identify students who required extra assistance with learning to read and who would also be most likely to work with someone who was unfamiliar to them (see Appendix C). The

[2] At the time of data collection, the Australian Curriculum had not been introduced.

teachers then sent consent letters to the identified students' families. Six families returned the consent forms and five students completed the 20 sessions. The five students who completed the 20 sessions had all been verified as having Global Developmental Delay. The sixth student was on the Autism Spectrum, and due to the researcher's inability to gather baseline data in respect to the student's reading skills, was not included in the study.

The DECS Disability Support Program, 2007 Eligibility Criteria (2007) identifies students with Global Developmental Delay as displaying cognitive skills and adaptive behaviours significantly behind those of their age peers. These students require significant additional support and curriculum accommodations to meet their individual learning needs. The DECS eligibility criteria (2007), p.3) also state that to be assessed as Globally Developmentally Delayed, students must show the following two characteristics:

- general intellectual ability two or more standard deviations below the mean on a standardised individual test of intelligence, or other evidence of significantly delayed intellectual development should the student's disabilities prevent standardised assessment
- a score of two or more standard deviations below the mean on a standardised assessment of adaptive behaviour for the composite score or in at least two of the following areas: communication skills, self-care, social and/or interpersonal skills, use of community resources, self-direction, leisure, and health and safety.

The Participants

Participants were five special class students from two schools, who had been identified with Global Developmental Delay and delayed reading skills. Four of the five students were identified as having *severe* speech and/or language disability. The fifth had communication difficulties that were classified as moderate.

Students with a speech and/or language difficulty are described within the DECS (2007) guidelines as students who:

- May have significant difficulty understanding spoken language resulting in frequent misunderstandings or not being able to follow information, requests, instructions and explanation.
- May also have significant difficulties expressing themselves orally preventing them from effectively communicating with others,
- May have significant difficulties in the production of speech sounds that prevent effective communication with others and difficulties with developing functional communication to meet every day needs (DECS', 2007, p. 8).

The four students with severe language delay, on commencement of school, all had difficulty expressing themselves and producing intelligible speech. All five students had some difficulty understanding spoken language, resulting in the need for the researcher to issue simple instructions to ensure understanding. All three areas of language delay, as described in the DECS (2007) guidelines, had improved over the time the students had attended school, but continued to impact on their ability to make the letter/sound correspondences required for accurate reading and verbal reproduction of letters or words.

The students varied in age from 6:7 years to 8:4 years, the average age being 7:4 years. Four of the five students commenced school in a mainstream/regular setting prior to being placed in a special class. The fifth student began school with a special class placement. Four of the students were male, and one female. All came from households where English was their first language (See Table 3-1). The students were given pseudonyms for purposes of privacy and confidentiality. All other references students made to people in their quoted conversations have also been changed to maintain confidentiality.

Table 3-1
Participant's Details

Name	Gender	Age At Time Of Intervention	Disability	Time At School	Commenced School In Special Class Or Mainstream	Intervention (see p. 66)
Jonathon	male	7yrs 0mths	Global developmental delay/Severe language delay	6 terms (4 terms in Reception and 2 terms in Year 1).	special class from commencement of school	sounding and blending of cvc words presented in rime families
Martin	male	7yrs 5mths	Global developmental delay/Severe language delay	8 terms (6 terms in Reception and 2 terms in Year 1)	mainstream 2 terms	sounding and blending of cvc words presented in rime families
Kris	male	7yrs 4mths	Global developmental delay/Severe language delay	9 terms (4 terms in reception, 4 terms in Year 1 and one term in Year 2).	mainstream 4 terms	sounding and blending of cvc words presented in rime families
Corrine	female	8yrs 4mths	Global developmental delay	3yr 1 term (4 terms in Reception, 4 terms in Year 1, 4 terms in Year 2 and 1 term in Year 3).	mainstream 4 terms	sounding and blending of cvc words presented in rime families
Jacob	male	6yrs 7mths	Global developmental delay/Severe language delay	5 terms (4 terms in Reception and one term in Year 1).	mainstream 4 terms	Grapho-phonic : letter/sound correspondence

Setting

Lessons were conducted in available classrooms or teaching areas at the student's school, based on the availability of a teaching space with an IWB and whether the randomised experimental schedule required access to an IWB or not. In both schools, all the classrooms had IWBs installed, and each of the students had had access to an IWB for at least four school terms prior to the intervention.

Design

A control group versus experimental group design was discounted due to the need for intensive one-to-one interaction with students with the backgrounds described above. A single-case experimental design that could accommodate such instruction with a small number of students was identified as being appropriate. Within the family of single-case designs (Barlow, Nock, & Hersen, 2009) the alternating treatment design enabled comparison of the students' performance in the IWB and non-IWB conditions.

The detailed observation that followed the teaching sessions also made single-subject design highly appropriate (Scruggs, Mastropieri, & Regan, 2006).

Single-Subject Design (SSD)

Special education research often focuses on the individual, making SSD research methods particularly suitable for this study (Horner et al., 2005). In this instance, the SSD focused on the reading needs of five students with intellectual disability and involved the teaching of a specific reading skill determined by their current graphophonic knowledge and ability to decode three letter consonant vowel consonant words.

The SSD research approach enabled the small number of students to be studied intensively, allowing evaluation of each student's behaviour across time and in two treatment conditions. The results remained individualised and were not averaged with the other students in the research group; enabling changes in behaviour to be identified that would otherwise be lost when merging data from a group of students (Kazdin, 1982; Neuman & McCormick, 2000; Shaughnessy, Zechmeister, & Zechmeister, 2003). Continuous assessment occurred over the experimental period to measure the effects of an intervention over time. Baseline data was collected to establish the level of performance on the targeted behaviour prior to the intervention, and data was then collected over 20 sessions of the intervention. Usually, a stable baseline is required before intervention can proceed to enable any changes in the baseline to be attributed to the intervention itself (Kazdin, 1982; Neuman & McCormick, 2000). However, an alternating treatments design (ATD), an effective form of SSD, does not have this requirement (Barlow & Hersen, 1984). An ATD is an experimentally sound and efficient method that can measure the performance of a particular student or group of students on more than one target behaviour and in more than one treatment condition (Neuman, 1995).

Alternating Treatments Design (ATD)

The ATD was an especially useful design for this instructional research (Sindelar, Rosenberg, & Wilson, 1985), as it enabled two treatment conditions to run concurrently. The two treatments alternated with each other on a randomised schedule, allowing observation of the effects of the interventions (Barlow & Hayes, 1979; Barlow & Hersen, 1984; Neuman, 1995), thereby providing an alternative approach for examining the relative effects of two or more interventions and enabling a comparison between the two conditions (Wolery, Gast, & Hammond, 2010).

In this design each treatment must be associated with a distinct and discriminative stimulus (Barlow & Hayes, 1979; Barlow & Hersen, 1984) to minimise one of the threats to internal validity (Kratochwill et al., 2013). The distinct stimulus in this study was the use, or not, of the IWB. In this instance, Treatment A (stimulus 1) involved teaching and learning using the IWB, drawing on its dynamic display features, and Treatment B (stimulus 2) involved teaching of the same type of material without the use of the IWB. Treatment B involved the use of more traditional teaching methods such as flash cards, magnets, games, play dough and writing. This enabled a clear distinction to be made between the two conditions and allowed the impact of teaching with the IWB on student engagement to be tested (see Table 3-2). The same graphophonic program, with a specific focus (sounding and blending or graphophonic) within each treatment condition, ran across the twenty sessions with each condition having its own graphemes or onset-rime focus which are displayed in Table 3-2. Sindelar et al. (1985, p. 69) noted the appropriateness of using an ATD approach when target behaviours cannot be reversed, and that the logic of the ATD does not require performance to revert to pre-instructional levels when teaching ends.

The ATD procedures control for other possible threats to internal validity, such as differential selection of subjects or history effects (Neuman, 1995). Other procedural considerations are the counterbalancing of the interventions; such as time of day, and location of each session, to increase the possibility that effects are due to experimental rather than extraneous conditions (Barlow & Hersen, 1984; Neuman, 1995). The scheduling of the two treatment conditions across the 20 sessions was randomised to further strengthen internal validity (Kratochwill & Levin, 2010), with the requirement that there be no more than three consecutive repeats of a single condition (Edgington, 1996; Reichow, Barton, Sewell, Good, & Wolery, 2010). All possible 'acceptable' repeat options were generated, using an on-line research randomiser program (http://www.randomizer.org/form.htm) and then further randomisation occurred by the random selection of an option for each student (Edgington, 1996 see Appendix D). No form of treatment exceeded three sessions in succession. This was important as an ATD required rapid alternation of treatments to obtain the necessary number of

Table 3-2
Sounding and blending activities taught and letters used across lessons

Blending skill	IWB: s a t b u g m r	Non-IWB: p i n l e d f r
onset-rime families	✓ at ag ug	✓ in ip ed
picture-word matching	✓	✓
cloze exercises	✓	✓
rebus exercises	✓	✓
memory game	✓	✓
word recognition games one rime, multiple rimes	Reading Doctor™	fish; snakes n ladders; Go Fish card game; bingo
word building (sound isolation/letter positioning)	drag n drop	magnets
tracing, copying	✓	✓
stories	✓	✓
identify onset, write	✓	✓
Researcher said word, student wrote	✓	✓
identify rime/rhyme	✓	
illustrate a sentence		✓

random observations (Barlow & Hayes, 1979; Barlow & Hersen, 1984) so that students could not anticipate the treatment to be received and to increase the probability that the observed effects were the result of the treatment rather than extraneous influences (Jones, 2006). Each treatment was repeated ten times to allow statistical comparison using randomisation tests (Dugard, File, & Todman, 2012; Jones, 2006), this repetition of treatment was also doubling the minimum of five repetitions required under the WWC Standards (Kratochwill et al., 2013) for each condition to control the effects of confounding variables. Information regarding the students' phonic and phonological knowledge was collected prior to implementation. Data concerning the students' engagement levels were collected during the intervention. The students' performance for each treatment has been plotted separately on graphs, to provide a ready visual representation of the effects of each treatment (Barlow & Hersen, 1984; Neuman, 1995).

Challenges identified in the design of lessons when using IWBs

The challenges identified in the research literature (Chapter 2) were taken into account during the design phase of the research method and during the implementation phase through lesson design.

For example, challenges such as the fast pace of lessons using IWBs (Tanner & Jones, 2007) and whole class instruction (Somekh et al., 2007) were not an issue as the lessons were paced according the progress of the individual student and taught on a 1:1 basis. The initial attraction of the bewitching capabilities or novelty effect of the IWB (for example Armstrong et al., 2005; Cogill, 2003; Hodge & Anderson, 2007) were also minimised with all students having had an IWB in their classroom for at least 12 months prior to the research commencing.

The possibility of presenting too much information to the students (Byrne & Fielding-Barnsley, 1995; Cutrim Schmid, 2008) was also addressed as all lessons were planned according to the students' current knowledge, drawing on the work of Ehri et al. (2001a). Only one or two phonological awareness skills were focussed on at a time, and each condition used both visual and aural input processing channels to minimise cognitive load (Sweller, 2006).

Procedure

All lessons were conducted in the morning. Each lesson was video recorded using a Canon digital video camera. The video sessions were downloaded to an external hard drive, enabling the researcher to view the footage at a convenient time, and on multiple occasions. The footage was analysed by the researcher using the Student Engagement Rating Scale observation system devised for the study (to be expanded upon in the next section) using a 30 second partial-interval sampling frame across the period of the recording. The 30 second partial-interval sampling interval was used because it provided a sound estimate of the occurrence of the target behaviours in a time frame during which such behaviours could be expected to be displayed and observed (Kennedy, 2005; Meany-Daboul, Roscoe, Bourret, & Ahearn, 2007). In this procedure task, affective and cognitive engagement behaviours in the first 30 second interval of each minute of the lesson were coded.

Lessons followed the format of having a rime introduced paired with a picture to aid comprehension. Following the introduction, different activities were introduced across the lessons to provide variety and repetition when learning the rime. The activities listed in Table 3-2 provided the students with opportunities such as identify sounds/ position of sounds in words, complete sentences, complete words by identifying the onset to the rime to match the picture prompt, to name a few. The tasks grew in complexity as the students became familiar with the words to provide greater context and meaning for the students in an attempt to keep them engaged with their learning.

Engagement Measures

Student engagement data was generated for each session. Video recordings of each session enabled observations of the students to be made using the Student Engagement Rating Scale (SERS) developed by the researcher (see Table 3-3 or Appendix A).

The student engagement categories observed were task, affective and cognitive engagement behaviours and are described briefly in Table 3-4 and with greater detail in Chapter 2. These three categories were chosen as researchers such as Fredericks et al., (2003), Lutz et al., (2006), Skinner and Belmont (2003) and Newmann, Wehlage and Lamborn (1992) identified the necessity of interest, effort and application to be present for student learning to take place and positive academic outcomes to be achieved. The categories were modified after comparing the observable engagement scales of researchers such as Dunlap (1984), Dunlap and Koegel (1980), Lutz et al., (2006) and Furlong and Christenson (2008) to be observable behaviours due to the cohort of students participating in the study and their intellectual disability/speech and language difficulties.

Table 3-3
Student Engagement Rating Scale (SERS)

Behaviours that identify task, affective and cognitive engagement: Final version 2010

	Really negative behaviours. No engagement behaviours displayed (Score 1)	Mildly negative behaviours. Passive, reluctant engagement behaviours displayed (Score 2)	Slightly positive behaviours. Few positive engagement behaviours displayed (Score 3)	Mostly positive behaviours. Mostly positive engagement behaviours displayed. Shows some spontaneous behaviours related to task. (Score 4)
Task engagement behaviours - Frequency of eye contact with teacher or task - Posture - Time on task	• No activity related to task, refuses to do task, pushes task away.	• On task rarely, reluctantly complies with instructions. Primary behaviour unrelated to task.	• On task some of the time, complies with instructions, but gets distracted, fidgety, does not perform task readily	• On task most of the time, performs task quickly and readily without interruption, attending.
	• No eye contact with teacher	• Looking towards teacher or activity, but not to engage.	• Eyes frequently on teacher or activity	• Predominantly watching teacher or activity
Affective engagement behaviours - Facial expressions, showing emotion. - persistence	• Sad, cries, pouts, angry, frustrated, tantrums.	• Not upset, but lacks real interest	• Shows some momentary, intense interest	• Shows sustained, intense interest
	• Child not enjoying self.	• Bored, expressionless	• Smiling, looks pleased	• Laughing appropriately, looking to interact with the Teacher, be part of the group.
	• No attempt to complete focus activity when persistence required	• Made some effort to complete focus activity with assistance when persistence required	• Made some effort on own, but also required assistance with focus activity when persistence required.	• Persisted with focus activity independently
Cognitive engagement behaviours	• **Selection** (use of material): *No sign* of selecting material	• **Selection** (use of material): selects material, but inappropriate to task	• **Selection** (use of material): selects some or part of the material, but not enough to complete task.	• **Selection** (use of material): selects correct material, completes task.
looking for any feature that connects material to anything the student knows or adds to the task	• **Elaboration** (relating to, or transformation of material): *no sign* of connecting material to prior learning	• **Elaboration** (relating to, or transformation of material): *with or without prompting*, but no clear connection with material. i.e. attempts to elaborate but comments unrelated to task i.e /i/ is for igloo when looking to read a word; no /i/ presented.	• **Elaboration** (relating to, or transformation of material): *with or without prompting* connects material with previous learning i.e. recognises written letter (selection) AND accurately produces sound (elaboration); recognises rime, then recalls other relevant words / ideas.	• **Elaboration** (relating to, or transformation of material): *no prompting required*, connects material with an original elaboration; extends ideas; creates other relevant words. Can include non-verbal responses i.e. writing, sign language. Can use pictures, letter clues, context to aid understanding
self-correction, questioning	• **Monitoring**: *no sign* of relevant questions, self-correction, recognition of error	• **Monitoring**: *with prompting* shows some recognition of error, but no clear connection or questions related to task.	• **Monitoring**: *with prompting* recognises error, some comments related to error and / or task. No relevant questioning.	• **Monitoring**: *with no prompting* self-corrects, asks relevant questions. Can include statements about the task, the environment.
Progress with a problem in terms of accuracy	• **Problem solving**: no progress or not required	• **Problem solving** : some progress with much assistance	• **Problem solving** : attempts on own, partially correct	• **Problem solving** carries out task spontaneously and accurately

Rule: if faced with 2 or more problems in a 30 second scaling timeframe, score the higher of the 2 to show change.

Table 3-4
Student Engagement – observable behaviours

Type of Engagement	Definition	Observable behaviour
Task	Engagement with the materials or researcher between trials, and being attentive (Dunlap, 1984; Dunlap & Koegel, 1980; Koegel & Egel, 1979).	Eye contact with task or teacher Time on task
Affective	The physical display of emotion; positive and negative reactions to teachers, learning and school. Affective engagement influences students' willingness to work. (Fredericks et al., 2004; Lutz et al., 2006)	Interest shown in activity or teacher directed instruction Mood displayed Persistence with task when faced with perceived or actual task difficulty
Cognitive	The effort necessary to comprehend complex ideas and skills and self-regulating performance to achieve set goals. (Fredericks et al., 2004; Furlong & Christenson, 2008)	Selection of appropriate material or strategy Elaboration relating to or transformation of material Monitoring or recognition of errors made or using questioning to clarify instructions/task Problem solving or having the ability to carry out the task

The SERS was trialled with students completing tasks during lesson time. The students' trialled were different students from a junior primary special class with intellectual disability who also had communication/language issues, reflecting the cohort of students who participated in this research. This trial showed that the SERS could be used effectively to identify the target engagement behaviours and that it yielded good inter-rater agreement reliability using two independent raters. Agreement was reached across a variety of participants and conditions on six out of six occasions.

Structured observation, the systematic observation of each student's behaviour (Denscombe, 2010) in terms of the schedule of categories identified in the SERS was undertaken. Bryman (2004) identified the need to establish rules prior to analysis so as to guide and inform the researcher as to what to look for and how to record the information. The video footage taken during each lesson was interval coded, using the first 30 seconds of each minute, rating the level of engagement being observed across the three types of engagement (task, affective and cognitive) (seeTable 3-3 or Appendix A). The scores for each type of engagement were then totalled and averaged to give each student an engagement score per lesson.

Observation ratings were checked for both inter-rater and intra-rater reliability. Two observers together considered sections of taped sessions to become clear on the interpretation of each code and rating. They then independently coded sections of tape and met to discuss the outcome of their results and to resolve any issues of interpretation by consensus. The number of agreements for each video session between the two observers was calculated as a percentage agreement; using the formula: 100 x (number of exact agreements)/(total number of observation points) (Dunlap, 1984; Dunlap & Koegel, 1980; Kennedy, 2005) . A further section of tape was then coded independently and the results compared. Agreement was greater than 90% with differences being resolved by consensus. Once consensus was agreed, the tapes were coded for analysis. The researcher also re-coded sections of video footage to check the interpretation of each code and rating. Inter-rater and intra-rater agreement data was important to collect to allow for a consistent standard to be established in regards to interpreting the SERS, to estimate the consistency in the collection of the data recorded and to ensure the consistency of the behaviour(s) being observed were those intended by the researcher (Kennedy, 2005).

The SERS categories were rated using a rating scale of 0-3. A rating of 0 indicated the student displayed none of the target engagement behaviours; a rating of 1 indicated the student was passive and/or reluctant to participate or displaying mildly negative engagement behaviours; a rating of 2 indicated the student was displaying slightly positive engagement behaviours but generally required some focussing or prompting by the researcher; and finally, a rating of 3 indicated the student was mostly positively engaged and showed some spontaneous, independent behaviours related to the task. The terms negative and positive engagement behaviours relate to whether the student actively and willingly participated in the lessons (positive), engaged in conversations and used appropriate material for the task at hand; or whether they were reluctant, selected correct material and used it inappropriately, attempted to engage in irrelevant chatter or be disinterested in the lessons (negative). The observed behaviours used to identify positive and negative drew on the work of Cooper and Brna (2002) Dunlap (1984), Dunlap and Koegel (1980), Furlong and Christenson (2008), Koegel and Egel (1979), Laevers (1994) and Lutz, Guthrie and Davis (2006) which was reviewed in the literature review (from page 26).

Student comments during each session were also noted in the recordings, as it was anticipated voluntary comments would provide an indicator of how the students felt towards lesson delivery or reading in general. It was anticipated these comments could also provide important information about the level of student understanding of the lesson material.

Data analysis

Three forms of analysis and representation were undertaken. The first utilised the visual inspection of graphically displayed data, as this is the most commonly used method of analysis in SSD and ATD (Barlow & Hersen, 1984; Horner et al., 2005; Kennedy, 2005). To further support the visual analysis of the data, the percentage of non-overlapping data points (PND) were examined (Scruggs, Mastropieri, & Castro, 1987) and the final tests undertaken were randomisation statistical tests to strengthen and support the interpretation of the data (Dugard et al., 2012; Levin, Ferron, & Kratochwill, 2012).

Scruggs et al. (1987) and Horner et al. (2005) state that visual analysis involves the interpretation of the level, trend and variability of performance occurring during the intervention. The level refers to the mean performance during a condition of the study. Trend references the rate of increase or decrease of the best-fit straight line for the dependent variable within a condition and variability refers to the degree to which performance fluctuates around a mean or slope across the observation occasions (Horner et al., 2005, p. 171).

The percentage of non-overlapping data points (PND) was the second form of analysis to take place. This measure is similar to a measure of effect size, such that complete overlap of scores in the two treatments can be interpreted as lack of effect of an intervention (Department for Communities and Social Inclusion, 2014; Grissom & Kim, 2012). The calculation of the PND within an ATD is different from its use in other SSDs. In this study consistent differences between corresponding data-point values of the alternating conditions were compared, rather than comparison of the data path of each condition against baseline data. For example, the first data-point value of Treatment A was compared with the first data-point value of Treatment B, until all paired data-point values were compared. Variability in the data paths of each condition is perhaps less important in the ATD comparison where the focus is on whether one condition is consistently superior to the other condition being compared over the ten sessions (Wolery et al., 2010, p. 352). According to Wolery et al., PND is the most critical statistic to report when comparing conditions of the ATD (p. 352). When interpreting the percentage of non-overlap between the treatment conditions, the higher the percentage, the greater the effectiveness of that treatment on the target behaviour (Scruggs et al., 1987). Scruggs and Mastropieri (2001) suggest that PND scores above 90 represent a strong difference between conditions akin to a large effect size. PND scores from 70 – 90 reflect a moderate difference, scores from 50 - 70 are regarded as indicating a minimal difference and scores below 50 are regarded as showing no difference between conditions. These guidelines have been used to interpret the PND results.

Finally, randomisation tests were undertaken to further assess whether one condition was superior to the other. Randomisation tests statistically rearrange the order of the lesson within each condition and between the two conditions (Kratochwill & Levin, 2010), and test the probability of obtaining the observed difference in the means of the two conditions when differences for all possible ordering of the lessons were calculated. If the probability of the observed difference in means was lower than an alpha level of five percent, then the results suggest the pattern of scores was associated with a statistically significant difference in the effects of the two conditions (Dugard et al., 2012).

Verbal responses

On commencement of data analysis, it was observed that the quantity of verbal communication varied between the two conditions. To test this observation, the video footage was further analysed to determine the type and amount of language produced by the students. Verbal responses were divided into three types. The first type of responses were those relevant to the task, for example when a student was responding to questions posed or prompted by the researcher, or when the student was responding directly to the task being presented. For example, if the researcher asked the student to sound /cat/ and they responded /c/a/t/, the response would be coded as relevant. The second response coded was a relevant response that was an *elaborated response*. These responses were those which added to the task, such as responding to the above question, and the student adding to the answer such as /c/a/t/; I have a /cat/, it is white and fluffy. This type of response indicated the student understood the word /cat/ and had connected it to their personal knowledge. Finally, *irrelevant responses* were identified. These responses were those which were unrelated to the task that the student was undertaking at the time.

Pre-Intervention Data

Pre-intervention data was collected to determine which Phase of Reading development, and which component of the phase (Ehri, 1995a), each participant had achieved, to enable the starting point to be established. Data continued to be collected during the intervention phase to determine any change in reading skills and whether or not the researcher needed to change the students' reading skill focus.

Reading Assessment

1. Grapho-phonic Knowledge

    Grapho-phonic knowledge was tested in two ways. The first test was of the students' ability to recognise the spoken phoneme by identifying the corresponding grapheme. Secondly, the students were shown the grapheme and were asked to identify the phoneme. Sixteen letters were presented, all being the grapho-phonemes that the researcher was to use in the vc and cvc test words, and in the intervention phase. The letters were presented randomly, in non-alphabetic order. The phonemes chosen for the research were most of the letters from the first three sets of the Jolly Phonics program (Set 1: s, a, t, p, i, n; Set 2: c, e, r, m, d; Set 3: g, u, l, f, b) (Jolly Learning Ltd, n.d.) and those that could be made into onset-rimes.

If the students were unable to identify the target phonemes and graphemes, lessons in grapho–phoneme correspondence commenced using the target letters identified above.

In the pre- and post-assessments, testing ceased after the false identification of four consecutive grapho-phonemes.

2. Sounding and Blending ability

    Each student's ability to blend sounds was tested using the same 16 phonemes in combinations that were not part of the proposed intervention. The students were each presented with four vowel consonant (vc) words, followed by 10 consonant vowel consonant (cvc) words.

The students were prompted to sound out and blend the words presented if they were unable to decode them independently. If the students were unable to sound and/or blend the vc or cvc words, lessons commenced targeting the skill of sounding and blending. Testing ceased after the false identification of four vc or cvc words in a row.

The vc, cvc test used was created specifically for this research. Skills such as sound isolation and segmenting were not tested. However, sound isolation was a component of some of the lessons taught.

Post-Assessment Data

The post-assessment data was collected after the completion of the twentieth teaching session, in a time that a teaching session would have taken place. The participants were given the same grapho-phonemes or words used in the pre-assessment. As in the pre-test, the participants in the vc/cvc intervention were prompted to use the strategy of sounding and blending if they approached the task without first recalling this strategy to decode the words presented.

Cognitive load

Lessons were rated according to the cognitive load placed on the students in terms of the number of rimes presented during a lesson. Sweller (1988) posited that two to four elements of a problem or task need to be considered at each step in a problem to reduce cognitive load. Therefore, one rime, with 3 – 4 words was explicitly taught to students, teaching them to identify and chunk the rime before introducing the next rime. The chunking of the rime involved the students becoming aware of, and identifying /at/ for example, is always /at/ as opposed to /a/t/, and whether a new word could be created by changing the onset. The number of rimes exposed to students in each lesson was then used as a measure of difficulty.

Ongoing Reading Performance measures

The students' phoneme and rime knowledge was tested at the beginning of each lesson. If they were unable to recall the previous phoneme or rime, the phoneme or rime was retaught. If they were able to recall the target phoneme(s) or rime(s), the lesson moved onto the next target phoneme or rime. This was consistent with the criterion used by Bradford, Shippen, Alberto, Houchins and Flores (2006) who would move onto the next area of focus if no more than one error occurred during the letter, word or story reading during the checkout step. In an attempt to maintain student engagement, a variety of different activities will be introduced around the same rime across lessons, to provide repetition (See Table 3-2 for activities used across lessons).

Intervention

Once pre-assessment data had been gathered and analysed, students were withdrawn from their regular classroom settings up to three times per week for 20 minute sessions. They participated in an explicit, systematic, synthetic graphophonic-based intervention using either the interactive whiteboard (IWB) or the traditional teaching approach (non-IWB), based on their current skill requirements. The number of weekly lessons varied depending on the health of the student and the timing of other irregularly occurring classroom or school based events, such as swimming week, sports day or in-school performances.

Instruction in a lesson focused on one skill only, whether it was graphophonic knowledge or the sounding and blending of vc or cvc words. Focussing on one or two skills only is an approach that is advocated by Ehri et al., (2001a) who recognised that students receiving instruction in only one or two phonological awareness skills, such as blending phonemes, exhibit stronger phonological awareness and stronger transfer to reading than students who were taught three or more phonological awareness skills (p. 275). Twenty lessons were implemented: ten sessions in each format, each focussing on one phonological skill as identified by the student's pre-assessment.

For the students in the sounding and blending intervention, the lessons were structured so the students were introduced to a new onset-rime family once they had demonstrated they could recall, sound and blend the previous onset-rime words. The grapho-phoneme lessons were also structured in this format.

The software used on the IWB, Reading Doctor™, was used in the IWB condition as it contained many of the multi-sensory features that are purported to 'enhance the students learning experience' (Smith et al., 2005). Reading Doctor™ (http://www.readingdoctor.com.au/) is a specialist literacy software that enabled the researcher to customise the sounds, letters, and blending skills that needed to be targeted using a synthetic phonics approach, while controlling the size of the learning set (Fitzgerald, Koury, & Mitchem, 2008). The Reading Doctor™ also allowed the separation of the IWB target letters/words from the traditional delivery target letters/words (see Table 3-2 for letters used in each condition). The Reading Doctor™ had built in scaffolds which faded as the student performed the task successfully and were reintroduced upon the making of an error to support student learning (Fitzgerald et al., 2008). The Reading Doctor™ and the researcher focused on mouth positions for the sounds, such as supported by Lindamood, Bell and Lindamood (1997), ensuring consistency across the two conditions. The program also had an Australian voice pronouncing the letters and words; and used image icons familiar to the student, such as a cricket bat in lieu of a baseball bat, to enhance the connection of existing knowledge of image to word.

As identified in Table 3-2, controlling the variables in the methods not relevant to the comparison of engagement between the IWB and non-IWB conditions was important. For example, the students were able to manipulate letters, pictures and words in both conditions; the same task content was included; students were able to ask or answer questions, receive corrective feedback and praise, and use materials that were engaging, interesting and educational. The features particular to the IWB were the pre-programed praise and encouragement, a time based system of answering questions within the Reading Doctor™ software. These features were not available with the general IWB interface, however moving images were included in some lessons in an attempt to capitalise upon the 'engaging' features of the IWB (Lee & Boyle, 2003; Slay et al., 2008; Tanner & Jones, 2007) to enhance memory. See Table 3-5 for a comparison of the built in features versus those provided by the researcher.

Table 3-5
IWB v non-IWB features

Feature of condition	IWB	Non-IWB
praise toward the student	• RD i.e. great job; awesome; keep it up ○ firework graphics or pictures randomly throughout attempts or consistently on completion • Other program: moving graphics i.e. person jumping for joy • Researcher i.e. well done; you're working hard	• Researcher i.e. well done; you're working hard
feedback providing informative feedback to student	• RD provision of answer if incorrect, automatic reset to beginning of task in relation to the word or letter error; if successful, a tick (√) would appear • Researcher: Vocals i.e. look at the word and sound out what you have done. Does it sound like the word /bat/?	• Researcher: Vocals i.e. look at the word and sound out what you have done. Does it sound like the word /pin/?

support
provision of assistance to student
	• RD programmed, consistent, fading on each successful attempt.
	  ○ Student could press on letters for the program to 'speak'
	  ○ Consistent definitions, images provided
	• Other program: layering to 'hide' incorrect responses and minimise further options; different colour print
	• Researcher: Pointing to tiles, rearranging tiles, providing opportunities to discuss meaning of words, relate to existing knowledge or experiences
	  ○ Modelling behaviour or skilled response
		• Researcher: Pointing to tiles, rearranging tiles, providing opportunities to discuss meaning of words, relate to existing knowledge or experiences
		  ○ Modelling behaviour or skilled response

pace teacher directing the speed of response of student	• RD determined by a built-in timer • Other/Researcher: Determined by student effort, knowledge and interest in task. • Researcher directed if student off task i.e. '*come on, only two to go*'.	• Determined by student effort, knowledge and interest in task. • Researcher directed if student off task i.e. '*come on, only two to go*'.

RD = Reading Doctor™

Researcher Bias in lessons

An independent rater observed a random selection of video footage across students to examine the researcher's interaction with the students in the two conditions to ensure there was no bias towards either condition. The researcher was rated on the level of *enthusiasm* displayed throughout a lesson, the *praise* provided to students for example '*good job', 'yes, that's right', 'you did that quickly*'; the *feedback* provided to students to enable them to continue successfully such as directing the students attention to the position of a letter or sound, for example saying '*look at the first letter'*; the *support* provided to a student such as naming the letter or sound, saying the word, pointing to words without verbal support or physically rearranging tiles on the desk top i.e. /rga/ to /rag/; *managing* student behaviour where the researcher requested the student back on task or to cease a certain behaviour; and finally controlling the *pace* of the lesson for example *'only 2 to go'.*

The Reading Doctor™ also provided much of the above support as outlined in Table 3-5 for example *praise* was built in both randomly and on successful completion of a word/letter being recognised, verbal praise such as '*great job'* and *'awesome'* were accompanied by graphics such as dancing feet and fireworks. *Feedback* was provided by the word or letters being verbally repeated, an icon appearing to match the word, letters/sounds/images highlighted to assist selection if time was running out. *Support* was consistently provided by the program, initially it sounded the word, provided a sentence cue (*We use a bat to play cricket*) and a visual mnemonic to support the word. The support systematically faded each time the student successfully solved the problem presented by having the picture fade and the word or letter verbalised less. The individual letter tiles also faded to finally present the word of focus only. For example on presentation of the word /bat/ on first presentation it would have been /b/a/t/ plus voice, a sentence putting the word in context, an image of a cricket bat and visual mnemonic behind each letter (*b*ed, *a*pple, *t*ap). By the fifth presentation only the word /bat/ would be visible. On the making of an error the support was automatically reset to the original settings. *Behaviour management* created through the use of bonus scores for working quickly, working correctly and for completing a task. *Pace* was determined by a built in timer. Further to the Reading Doctor™ features, when using the independently created IWB flipchart pages, *support* was provided by the layering of letters so if an incorrect choice was made the letters would remain 'hidden' to minimise the choices available or a different colour print was used to highlight the correct letters from the distractors.

Independent rater

The independent rater reviewed an equal number of lessons in both the IWB and non-IWB conditions to determine whether the researcher approached the lessons with more or less enthusiasm, or provided more support, praise, feedback and behaviour management or controlled the pace of the lessons more in one condition over the other. Due to the variance in lesson length, the scores were then averaged to the nearest 15 seconds. These results are presented in Table 3-6.

Initially, both the independent rater and the researcher reached agreement on the definitions of the constructs to be observed, then together watched some lesson footage to ensure a mutual understanding of the terms across the constructs. The independent rater then independently viewed and rated six random videos across students and lessons.

Table 3-6
Average responses received by students per lesson by researcher only and the IWB, the IWB programs and researcher (IWB) or researcher only (non-IWB)

	IWB RD and researcher M(SD)	non-IWB researcher only M(SD)
enthusiasm throughout the lesson	.044 (0.18)	0.38 (0.34)
praise toward the student	2.97 (1.80)	0.92 (1.01)
feedback providing informative feedback to student	6.36 (2.91)	3.39 (2.70)
support provision of assistance to student	13.18 (5.65)	2.20 (0.57)
management researcher behaviour that requested the student to be on task or cease certain behaviour	0.79 (1.15)	0.27 (0.57)
pace teacher directing the speed of response of student	0.9. (0.10)	0.21 (0.20)

Upon conducting both a Wilcoxon signed rank test (related samples) and a Paired samples t-test it can be determined that there was no statistical difference was evident between the two conditions, therefore there was no researcher bias in any of the above constructs.

4. JONATHON

Jonathon, at the time of instruction, was 7 years 0 months of age and had been at school for six terms. He had been identified with Global Developmental Delay and a severe language delay when in kindergarten (pre-school), and placed in a special class on commencement of school.

Lesson History

Jonathon presented as a very happy boy, who tried to please his teachers, carers, and significant others. His ability to communicate orally, and through other means such as sign or augmented communication options, was severely limited. When Jonathon first commenced school as a 5 year old, the only sound he could pronounce was ‘mmm’, and every attempt at verbal communication consisted of a series of ‘m’ utterances, and much gesticulation. At the time of his participation, Jonathon was able to produce all single sounds of the alphabet and put together a series of words to successfully convey meaning. He was also able to enunciate all cvc words; however, he continued to struggle with the pronunciation of many multiple letter blends such as /gl/, /bl/ and /spr/. Despite his language difficulties, he rarely showed frustration when attempting to communicate, persisting with hand signals, words or sounds in an attempt to communicate meaning. He eagerly came to each session, and once withdrawn from his class, would happily wait for the lesson to start or attempt to anticipate the activities of the lesson and commence work without instruction.

Pre-test and post-test reading task results

The first phase of testing involved the random presentation of the sixteen letters identified in the Method chapter. They were presented in both print and verbal format. Jonathon successfully identified the 16 letters, so was then presented with vc and cvc words. The words used in the pre- and post-test were generated from the 16 letters initially presented and were the same letters used in the twenty teaching sessions (eight in each condition). The words presented were not words explicitly taught during the intervention.

Prior to intervention, Jonathon was presented with a list of vowel consonant (vc) and consonant vowel consonant (cvc) words. He was able to read two of the four vc words, and made no attempt to read the cvc words, responding with *'I don't know'*. Testing ceased after Jonathon was unable to correctly identify the first four cvc words presented. On completion of the 20 lessons, Jonathon successfully read the four vc words and used the blending and sounding strategy taught to read the ten cvc words. Table 4-1 displays Jonathon's pre- and post-test results.

Table 4-1
Jonathon: Pre and Post test results

Word presented	Pre-test	Percentage correct	Post test	Percentage correct
vc		**50%**		**100%**
an	at	x	an	✓
on	on	✓	on	✓
it	it	✓	it	✓
is		x	is	✓
cvc		**0%**		**100%**
ran		x	ran	✓
bed		x	bed	✓
mop		x	mop	✓
bin			bin	✓
leg			leg	✓
pat			pat	✓
dog			dog	✓
sad			sad	✓
pig			pig	✓
fan			fan	✓

Engagement

The means were calculated for the ratings of each of the engagement behaviour constructs and are presented in Table 4-2. Engagement behaviours were unable to be coded in lesson one, due to the IWB not communicating with the laptop. However Jonathon did complete the lesson on the laptop, and so was introduced to the first rime and the Reading Doctor™ software.

Table 4-2
Jonathan: Means and Ranges for Engagement Behaviours

	Task Engagement Behaviours		Affective Engagement Behaviours		Cognitive Engagement Behaviours	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.83 (0.17)	2.55 – 3.00	2.55 (0.13)	2.37 – 2.73	1.22 (0.15)	0.99 – 1.45
Non-IWB	2.67 (0.20)	2.40 – 2.89	2.58 (0.12)	2.40 – 2.75	1.33 (0.25)	0.98 – 1.80

IWB N = 9; non-IWB N = 10

Across the two conditions, the average engagement levels were in the high range for two of the three engagement constructs. For task engagement the IWB condition mean is slightly higher than the non-IWB mean. The affective engagement construct means are very alike in both conditions, scoring in the high positive range. The cognitive engagement construct averaged in the negative behaviour range, with the non-IWB scoring slightly higher than the IWB.

Table 4-3
Jonathon: Correlations between ratings for the three engagement constructs of task, affect and cognition across the IWB and Non-IWB conditions

Lesson Type		**Level of Affective Engagement**	**Level of Cognitive Engagement**
IWB N= 9	Level of Task Engagement	.761*	.855**
	Level of Affective Engagement		.831**
Non-IWB N=10	Level of Task Engagement	.887**	.781**
	Level of Affective Engagement		.734*

*. Correlation is significant at the 0.05 level (1-tailed).
**. Correlation is significant at the 0.01 level (1-tailed).

The correlations shown in Table 4-3 indicate that there were strong, positive relationships among the ratings for the three engagement constructs, indicating that when Jonathon was positively task engaged, he also tended to be strongly and positively engaged in the areas of affect and cognition. All correlations were statistically significant.

Each of these engagement constructs will be discussed further in the chapter.

Task Engagement

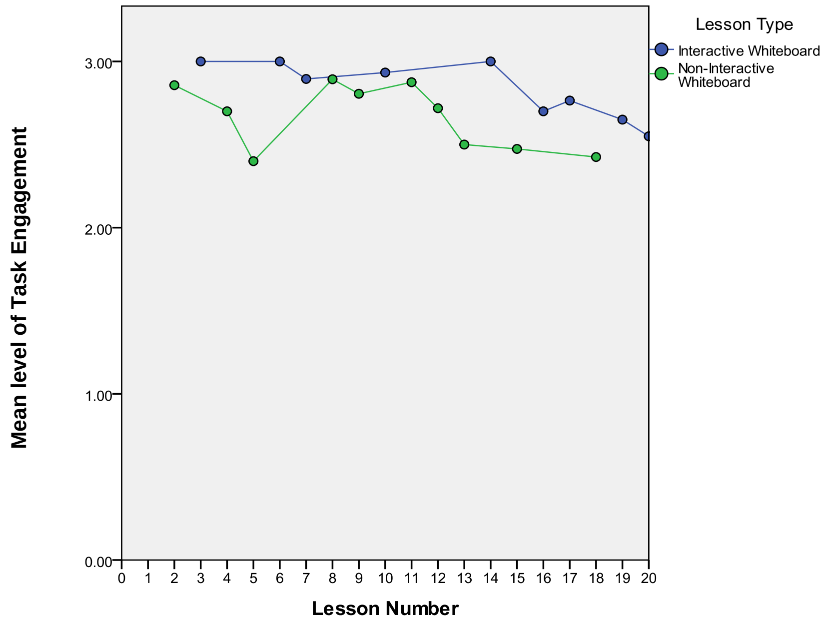


Figure 4-1
Jonathon: Mean Level of Task Engagement behaviours per lesson
Task engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

Figure 4-1 depicts the mean level of task engagement behaviours that Jonathon displayed across the 19 lessons involving the two conditions. It is evident from this diagram that his level of task engagement was high in both conditions. Across both conditions, task engagement fell slightly towards the tenth session, corresponding with the increase in the number of rimes to which Jonathon had been introduced. As the lessons progressed, Jonathon was also introduced to 'wordier' problems such as sentences and stories which also led to less picture prompts being provided to aid decoding. The final lesson in both the IWB condition and the non-IWB condition introduced a story that contained all the words taught specific to the individual condition.

The means for task engagement behaviours are presented in Table 4-2 and show the IWB with a higher average rating of 2.83 (range 2.55 – 3.00) when compared to the non-IWB mean of 2.67 (range 2.40 – 2.89). The PND analysis indicated Jonathon showed a higher level of task engagement in the IWB condition, having a moderate score of 80%. The randomisation test analysis showed the probability value of a RSS value of 0.073, which is not a statistically significant difference between the conditions at α < .05 level.

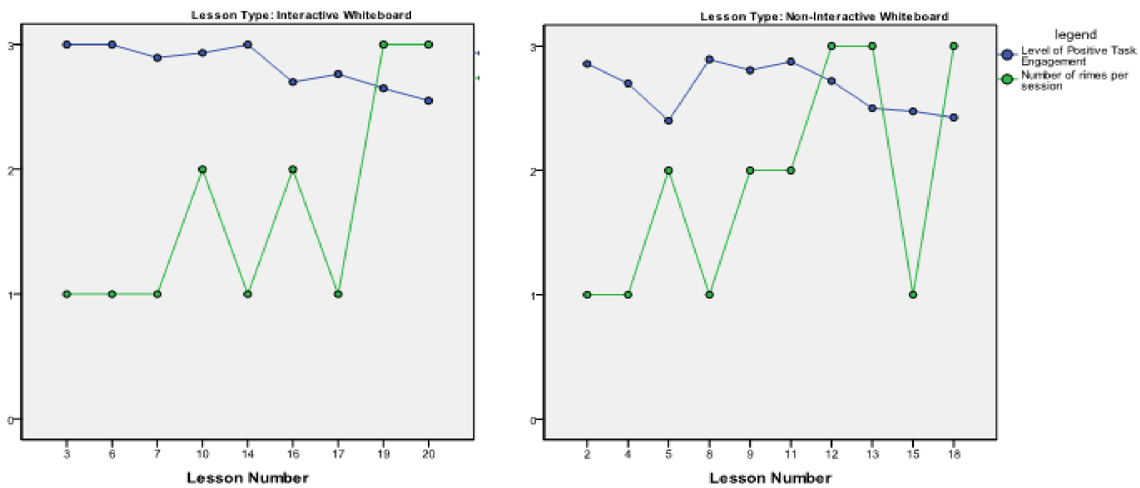


Figure 4-2
Jonathon: Task engagement and number of rimes per lesson per IWB and non-IWB conditions

Figure 4-2 shows a comparison of task engagement ratings across the IWB and non-IWB conditions in relation to the number of rimes presented to Jonathon. The graph depicts a drop in task engagement on two (L5 and L16) of the four sessions when new rimes were first introduced to Jonathon, in lesson 9 when two rimes were incorporated, and on each of the occasions three rimes were integrated into the one lesson (L19 and L20 IWB; L12, L15 and L18 non-IWB). This suggests that task engagement could have been negatively affected by increases in the cognitive load experienced by Jonathon. Cognitive load will be discussed in more detail towards the end of the chapter, following the analysis of the three engagement constructs.

Next is the comparison of the individual elements that make up the task engagement construct and Jonathon's behaviour.

Individual Elements of Task Engagement

The overall Task Engagement construct consisted of two elements; task related behaviour and eye contact with the researcher or the task. Task related behaviours consisted of those behaviours that were directed towards the task, where Jonathon was actively participating in the activities throughout the lesson. The eye contact element indicated when Jonathon was actively looking towards the researcher during instruction time, toward the activity itself or the materials.

Table 4-4 provides Jonathan's mean scores on each of these elements and Figure 4-3 depicts the mean scores for each lesson in the two conditions.

Table 4-4
Jonathon: Average Task Engagement Behaviours per lesson

	Task Engagement Behaviours – activity related behaviour		Task Engagement Behaviours – eye contact	
	M (SD)	Range	M (SD)	Range
IWB	2.79 (0.22)	2.40 – 3.00	2.87 (0.13)	2.70 – 3.00
Non-IWB	2.64 (0.25)	2.20 – 2.93	2.69 (0.18)	2.40 – 2.90

The means presented in Table 4-4 show Jonathon's activity related behaviour and eye contact was high across both conditions. The score in the IWB condition was higher across both elements.

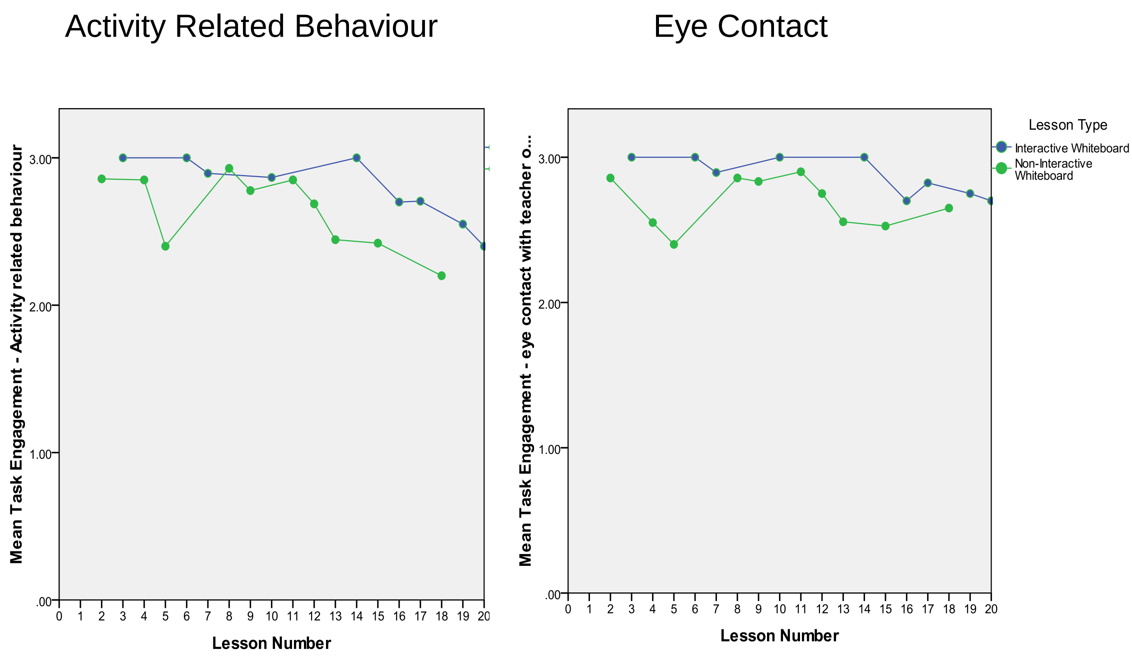


Figure 4-3
Jonathon: Average Activity Related Behaviour and Eye contact

The individual graphs presented in Figure 4-3 reflect those for task engagement as a whole shown in Figure 4-1, whereby, Jonathon was more task engaged in the IWB condition than the non-IWB condition. The mean scores presented in Table 4-4 support the visual data, as does the analyses generated by examination of PND in both elements in which a score of 89% of the IWB lessons scored higher ratings than the non-IWB lessons, indicating the IWB condition was highly effective. The randomisation test analysis showed no difference between the two conditions with a probability value of a RSS value of 0.19 for activity related behaviour, which does not indicate a statistically significant difference between the conditions at $\alpha < .05$ level. However the probability value for eye contact was 0.016, a statistically significant result in favour of the IWB condition at $\alpha < .05$ level.

Jonathon showed higher task engagement behaviour in the IWB condition, this being most clear in terms of the level of his eye contact.

Affective Engagement

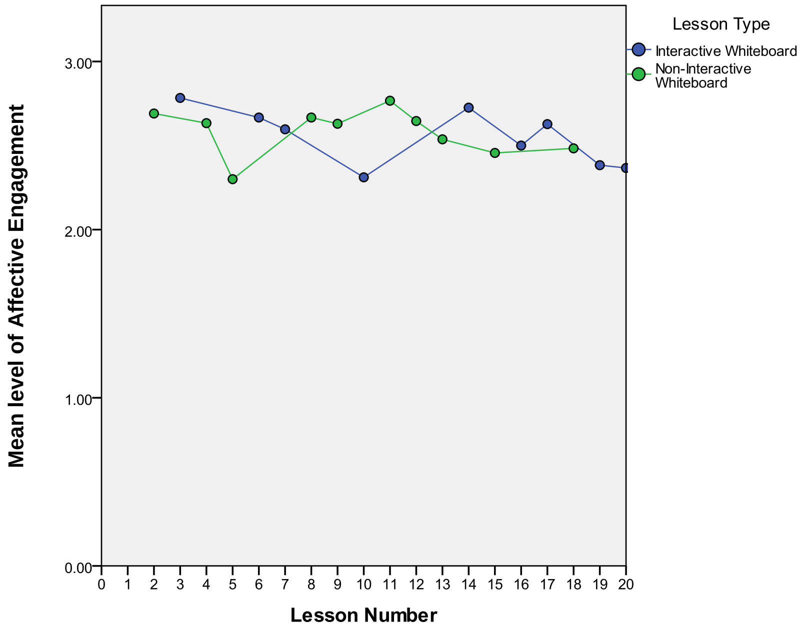


Figure 4-4
Jonathon: Mean level of Affective Engagement Behaviours per Lesson
Affective engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

As indicated by the closeness of the mean scores for affective engagement shown in Table 4-2, and by the pattern depicted across the lessons shown in Figure 4-4, neither condition can be determined as being more affectively engaging than the other. In both conditions, affective engagement behaviours were mostly positive, with the average lesson score fluctuating between mildly and mostly positive. The overall trend for affective engagement was slightly negative. The mean scores for affective engagement were 2.55 (range 2.37 – 2.73) for the IWB condition and 2.58 (range 2.40 - 2.75) for the non-IWB condition. The PND analysis favoured the non-IWB condition 67% of the time. The randomisation test analysis showed no distinction between the two conditions with a probability value of a RSS value of 0.61, which does not indicate a statistically significant difference between the conditions at $\alpha < .05$ level.

Generally, Jonathon showed interest in the activities presented to him, was happy to be a part of the program, and when faced with a difficult problem, showed some persistence by attempting to solve the problem independently, rather than giving up and moving on to the next activity or engaging in avoidance behaviours.

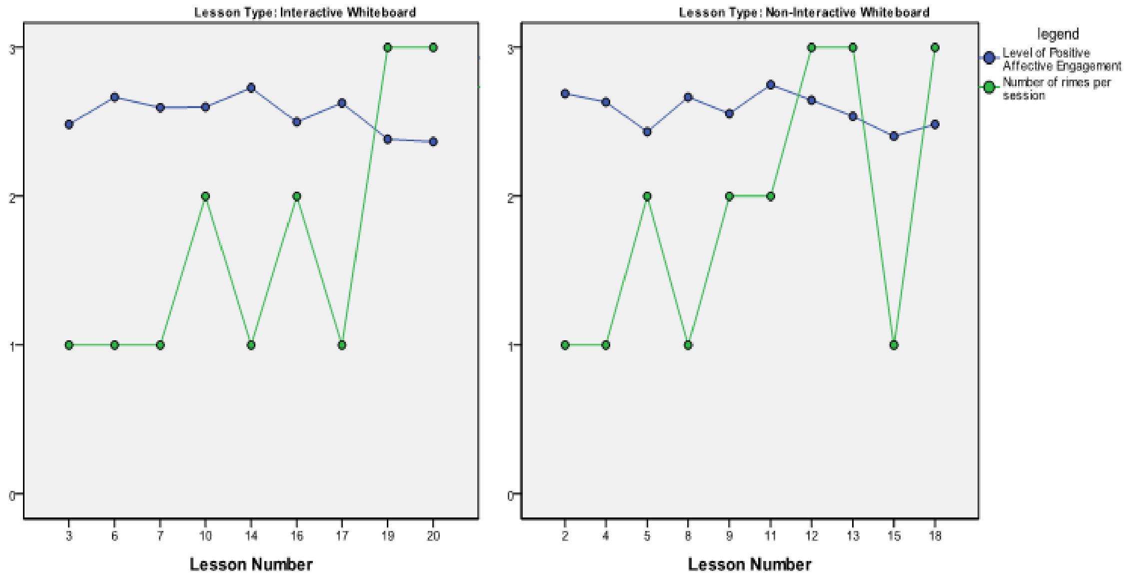


Figure 4-5
Jonathon: Affective engagement and number of rimes per lesson per IWB and non-IWB conditions

Figure 4-5 relates affective engagement levels across the two conditions to the number of rimes presented. The graph shows a drop in affective engagement in lesson 16 in the IWB condition, when the third rime was introduced, and on the introduction of the second rime in lesson 5 in the non-IWB condition. The fluctuation in both cases was minor, indicating that the introduction of a new rime had little impact on Jonathon's affective disposition towards the tasks.

Individual Elements of Affective Engagement

The overall Affective Engagement construct consisted of three elements; interest, mood and persistence. The means for each of these elements are presented in Table 4-5 and the depictions of the scores across lessons are displayed in Figure 4-6 .

Table 4-5
Jonathon: Average Affective Engagement Behaviours per lesson

	Affective Engagement Behaviours - Interest		Affective Engagement Behaviours - Mood		Affective Engagement Behaviours - Persistence	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.74 (0.28)	2.20 - 3.00	2.12 (0.14)	2.00 – 2.40	2.79 (0.21)	2.40 – 3.00
Non-IWB	2.69 (0.21)	2.35 – 3.00	2.23 (0.15)	2.00 – 2.45	2.82 (0.16)	2.58 – 3.00

The scores for all the elements reflect the pattern for overall affective engagement discussed earlier. Jonathon displayed sustained interest in the lessons/material presented to him, his mood was generally that of a pleased and happy disposition, and when persistence was required to complete tasks, he was willing to make some sustained effort on his own, even though he did require some assistance with the focus activity when the task became more difficult. Such assistance provided would be an oral or pictorial prompt provided by the researcher, such as sounding out the word, reading the sentence, or drawing his attention to the letters or pictures provided.

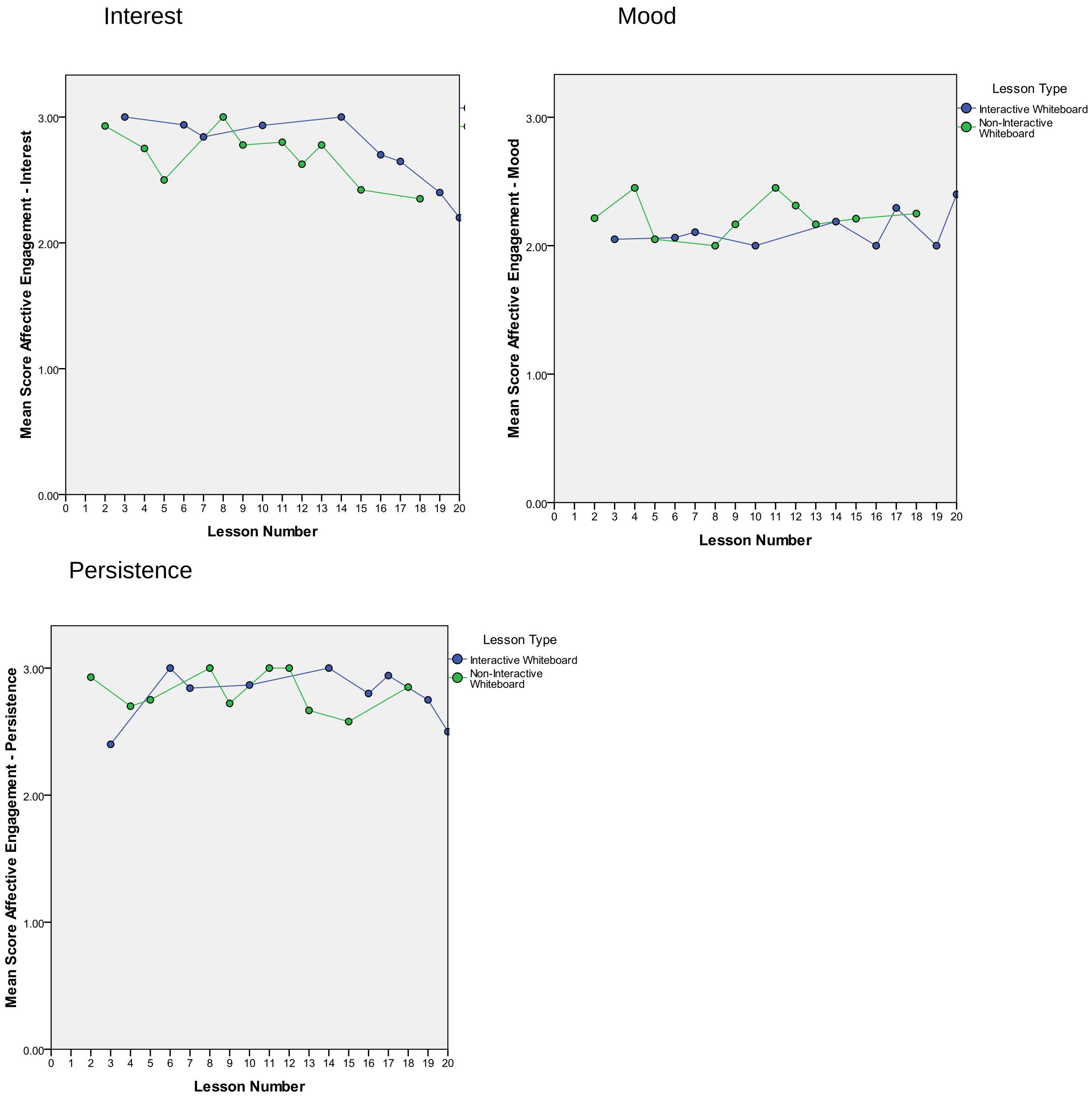


Figure 4-6

Jonathon: Average Interest, Mood and Persistence

Interest Scale: 3) shows sustained, intense interest; 2) shows some momentary, intense interest; 1) not upset, but lacks real interest; 0) sad, cries, pouts, angry, frustrated, tantrums. Mood Scale: 3) laughing appropriately, looking to interact with the teacher be part of the group; 2) smiling, looks pleased; 1) bored, expressionless; 0) child not enjoying self. Persistence Scale: 3) independently continued with focus activity, especially when faced with a difficulty/error; 2) attempted to continue on own, but required some assistance to continue with the focus activity; 1) made some effort to complete the focus activity with assistance, no effort when persistence required; 0) no attempt to complete activity when faced with an error/difficulty.

The analysis of the PND reflected the pattern of the mean scores presented in Table 4-5, where there is a minimal, one lesson preference for the IWB in the interest element (55%), a one lesson preference in favour of the non-IWB (55%) in the mood element and no difference between the conditions in the persistence element. The randomisation test analysis showed no differentiation between the two conditions with a probability value of a RSS value of 0.69, 0.14 and 0.70 for interest, mood and persistence respectively, which does not indicate a statistically significant difference between the conditions at α < .05 level.

Overall, with respect to affective engagement, there is no strong basis to claim a clear preference towards one or other teaching condition.

Cognitive engagement

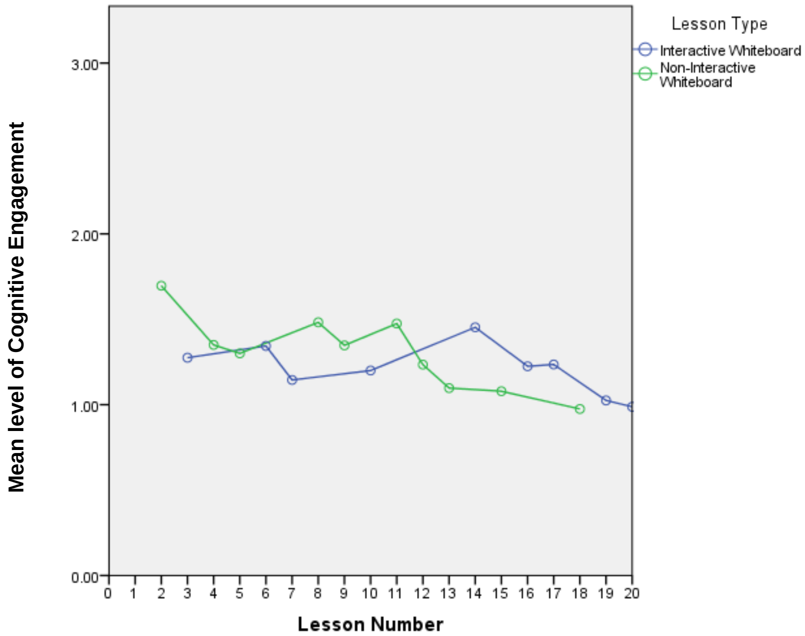


Figure 4-7
Jonathon: Mean Level of Cognitive Engagement Per Lesson
Cognitive engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

The cognitive engagement scale was used to scale the behaviours of the student in relation to four elements: the appropriateness of the selection of materials; the relating to, or transformation of, information; self-monitoring of actions in relation to asking relevant questions or correcting mistakes; and attempts at problem solving, whether independently and spontaneously or with assistance. As indicated in Table 4-2 and depicted in Figure 4-7, the mean cognitive engagement score in the IWB condition was slightly lower than that for the non-IWB condition. The PND analysis indicated no overall preference for either condition and the randomisation test analysis showed no preference between the two conditions with a probability value of a RSS value of 0.30, which was not significant at $\alpha < .05$ level.

The overall level of cognitive engagement was at a much lower level than both task and affective engagement indicating that Jonathon generally required help to correctly select the appropriate materials to complete the task, rarely elaborated on the words or tasks presented, made few attempts to self-monitor his problem solving results, and required much researcher assistance to solve the problems presented.

The overall trend in level of cognitive engagement across time was slightly negative across both conditions, which appears to be related to the increasing cognitive load across the lessons. The relationship between number of rimes and cognitive engagement is depicted in Figure 4-8.

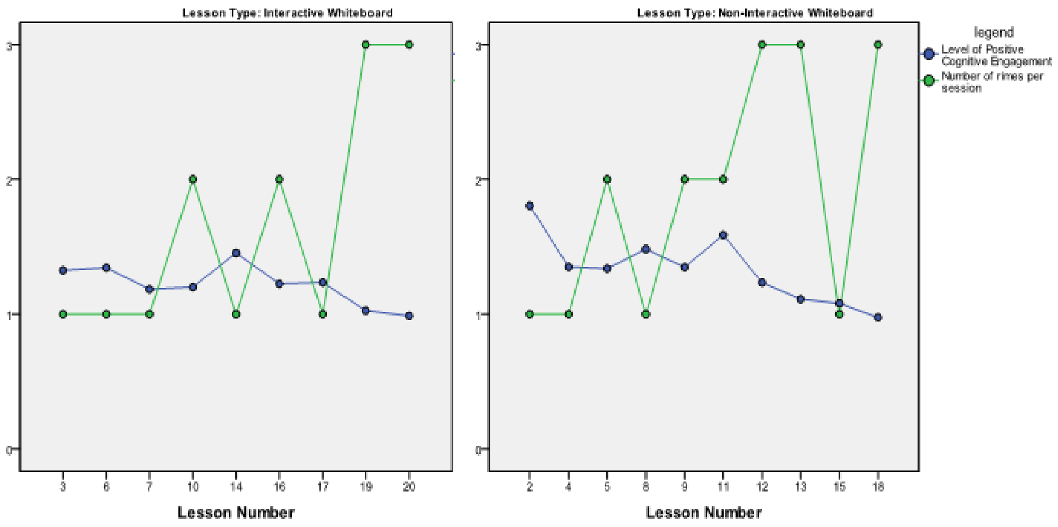


Figure 4-8
Jonathon: Cognitive engagement and number of rimes per lesson per IWB and non-IWB conditions

As was the case with the Task Engagement and Affective Engagement constructs (Figure 4-1 and Figure 4-4 respectively), the level of cognitive engagement fell towards the tenth session, more so in the non-IWB condition than the IWB condition. This decline in cognitive engagement corresponded with the increase in the number of rimes Jonathon was presented in the lessons, regardless of the condition. This decline was particularly evident in the non-IWB condition on the introduction of the first new rime (lesson 5) and the lessons with three rimes per session, being lessons 19 and 20 in the IWB condition, and lessons 12, 13 and 18 in the non-IWB condition.

The next section will look at these individual cognitive engagement elements in more detail as the overall summary blends the individual details.

Individual Elements of Cognitive Engagement

Table 4-6
Jonathon: Average Cognitive Engagement Behaviours per lesson

	Selection		Elaboration		Monitoring		Problem Solving	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.56 (0.27)	2.10 – 3.00	0.08 (0.10)	0.00 – 0.25	0.21 (0.23)	0.00 – 0.75	1.92 (0.34)	1.50 – 2.50
Non-IWB	2.56 (0.25)	2.21 – 2.94	0.52 (0.39)	0.00 – 1.00	0.46 (0.36)	0.13 – 1.14	1.78 (0.32)	1.28 – 2.21

The means are presented in Table 4-6 for the four individual elements of Cognitive Engagement. The means for the Selection element indicated Jonathon was consistently able to select the appropriate materials to complete the set task in both conditions. The Elaboration element mean was in the very low to mildly low range indicating Jonathon rarely elaborated or connected the target word or components of the word to existing knowledge aloud, but if he was to make any observable connection with his prior knowledge, it was more likely to occur in the non-IWB condition. The mean for the Monitoring element was also in the very low to mildly low range indicating he rarely independently checked his answers for accuracy. However, on the rare occasion in which Jonathon did check his answers it was more likely to occur in the non-IWB condition. Finally, the mean for the Problem Solving element averaged in the mildly positive engagement behaviours, which indicate that Jonathon, with some assistance, could reach the desired outcome for the set task, and slightly more independently in the IWB condition.

Selection

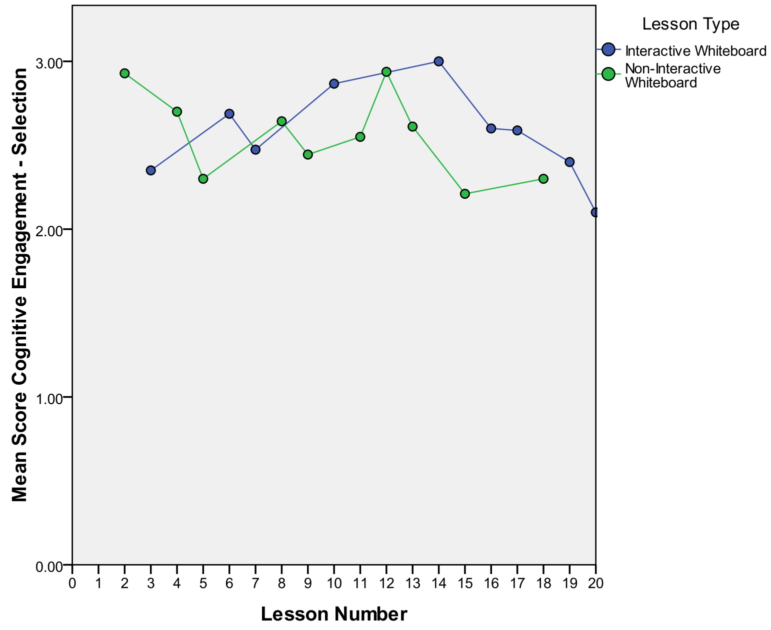


Figure 4-9
Jonathon: Average appropriate selection attempts per lesson
Selection Scale: 3) independently selects correct material to complete the task; 2) selects some or part of the material, but not enough to complete the task; 1) selects material, but inappropriate to the task; 0) no sign of selecting the material.

In both the IWB and non-IWB conditions, Jonathon showed evidence of frequent selection activity indicating that he could appropriately and independently, select and use the materials required to complete the tasks at hand. This is depicted in Figure 4-9. The means for the two conditions were at similar levels (as shown in Table 4-6) and on calculation of the PND, a minimal preference of 56% was found towards the non-IWB condition. No statistical significance was found when the randomisation test analysis was performed with a probability value of a RSS score of 0.99, somewhat greater than $\alpha < .05$ level.

Elaboration

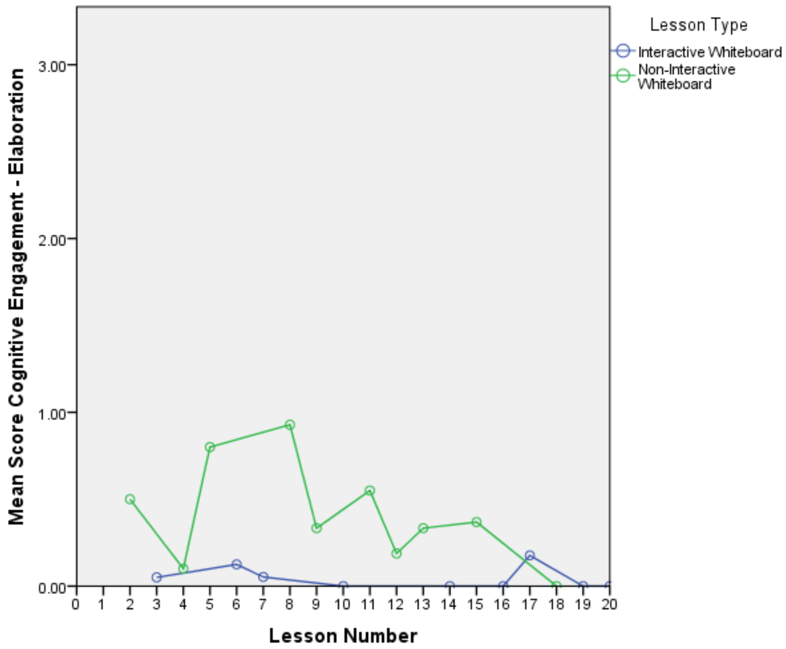


Figure 4-10
Jonathon: Average elaborated verbal or non-verbal responses per lesson
Elaboration Scale: 3: independently connects material with an original elaboration, extends ideas, creates other relevant word. Can include non-verbal responses; 2: with or without prompting, connects material with previous learning; 1: with or without prompting, attempts to elaborate, but no clear connection with the material; 0: no sign of connecting material to prior learning.

The elaboration element recognised any verbal response or physical behaviour made by Jonathon that connected the material to any relevant prior knowledge. The mean level of elaboration activity was in the very low range in both conditions (see Table 4-6). However, when comparing the results in Figure 4-10 and the frequency of elaborations in Figure 4-11, it becomes apparent that Jonathon produced more elaborated responses in the non-IWB condition. The randomisation test analysis indicated a statistically significant result in favour of the non-IWB condition at .0009 at α < .001 level.

In the non-IWB lesson Jonathon would display his knowledge of the letters or words (*'f for fish'; 'ip, hip'*), and/or attempt to create words out of either the letter cards or magnets before him (forms /hui/ out of the magnets).

The highest number of elaborated verbal or non-verbal responses in one lesson was six. Conversely, in the IWB condition, only on four occasions did he extend his response to more than the required answer.

A fuller example of an elaborated verbal response combined with a non-verbal behaviour was when Jonathon spontaneously attempted to create a word with the letter magnets - /flin/. After the researcher congratulated him on his attempt, and responded that it was not quite a word, he responded emphatically '*That is a nord'*. The researcher asked '*What's a flin*?' Jonathon responded non-verbally, making the action of playing a violin.

In lesson 15, Jonathon announced spontaneously that he '*uses blending in school*', indicating (by pointing to his classroom) that he had transferred the sounding and blending skill to the classroom, a behaviour confirmed by his classroom teacher.

Verbal Elaborations

Verbal responses were utterances recorded that were either irrelevant and not task related such as talking about a friend, or relevant elaborations related to the task, such as connecting components of the task to anything the student knew about that component or task during a recording period.

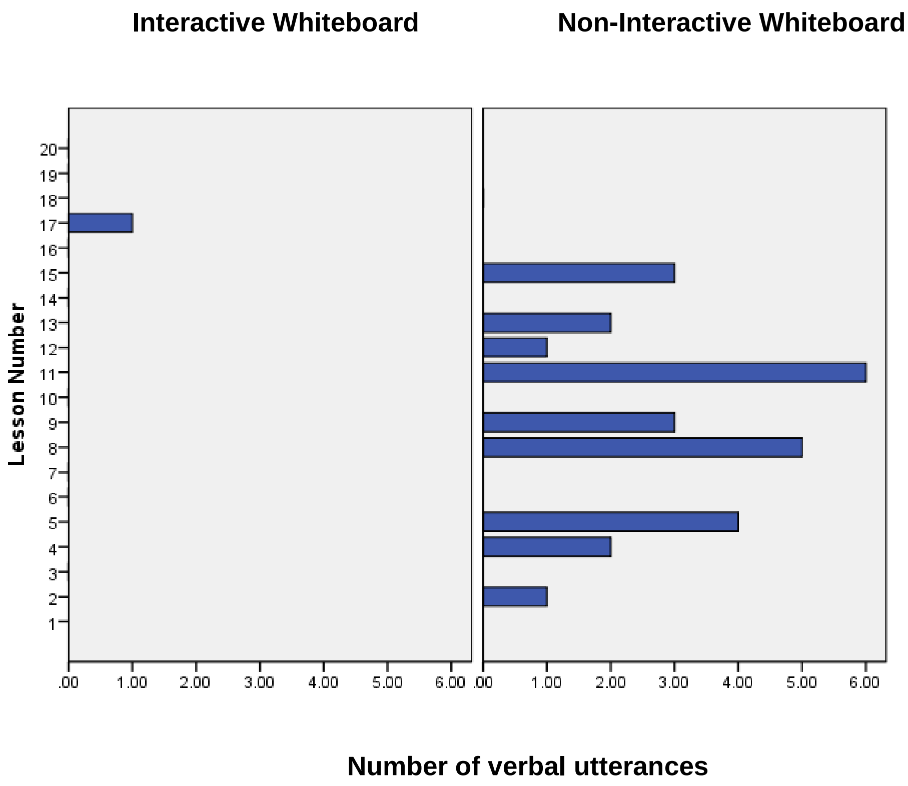


Figure 4-11
Jonathon: Occurence of relevant elaborated language per condition and lesson
IWB frequency = 1 relevant; non-IWB frequency = 27 relevant

Jonathon did not register any irrelevant language during the recording periods whilst there were some relevant, verbal elaborations. The data may appear different to that in Figure 4-10 as that figure also included non-verbal elaborations. For example, in the non-IWB condition, Jonathon picked up the letter /i/ and verbally related it to '*i is for igloo'*. This incident was recorded in both the elaborations figure and verbal responses. However, the independent writing attempt of 'Jonathon goes in the house', where Jonathon showed he understood the word /in/, is not included in the verbal elaborations figure (Figure 4-11).

Jonathon's quantity of language varied, depending on the difficulty of the task. As tasks required more conscious effort, he would respond with the minimum answer required, such as sounding the letters or responding to a question, without any elaborations. Often, in a recording period, he would not make a verbal response if he was selecting task elements and working on his problem solving independently. Across the twenty sessions, Jonathon did not attempt to engage the researcher in non-task (irrelevant) related conversations.

As can be seen in Figure 4-11 there is a noteworthy difference in the quantity of verbal elaborations produced across the two conditions. The non-IWB condition had at least one use of elaborated language in nine of the ten lessons, whereas elaborated language in the IWB condition occurred on only one occasion.

The majority of language generated by Jonathon when using the IWB was connected to the task, and therefore does not appear in Figure 4-11 – sounding out the letters and blending them, sometimes sounding out the letters of other words that appeared i.e. when the Reading Doctor™ was loading he would sound out /l/o/a/d/i/n/g/; was associated with the board itself – '*I can't see it'*; or associated with sense of achievement – '*Easy!*'. On one occasion, lesson 17, he corrected the researcher's interpretation of the target word /rug/: '*A rug goes outside;* '*That's not a rug, it's a mat'.*

Conversely, the relevant verbal language generated during the non-IWB lessons was far richer, with Jonathon attempting to make words '*I can make a nord*.'; *'what happens if I do*…(followed by an action or creation of a word)*'*. Often Jonathon would spontaneously elaborate on what he was doing, such as '*d for dog'*, ' *e,e,e,e elephant and e,e,e end'* or singing whilst holding individual letters '*little, little i o'*. Much of Jonathon's non-IWB conversation was associated with him confirming or showing his comprehension of the word being learnt such as '/nip/ ' then puts his fingers in his mouth ''*nip was sharp, that was silly, sharp uho that be…' (*then referred to a picture*).* This type of elaboration was not seen in the IWB condition.

Monitoring

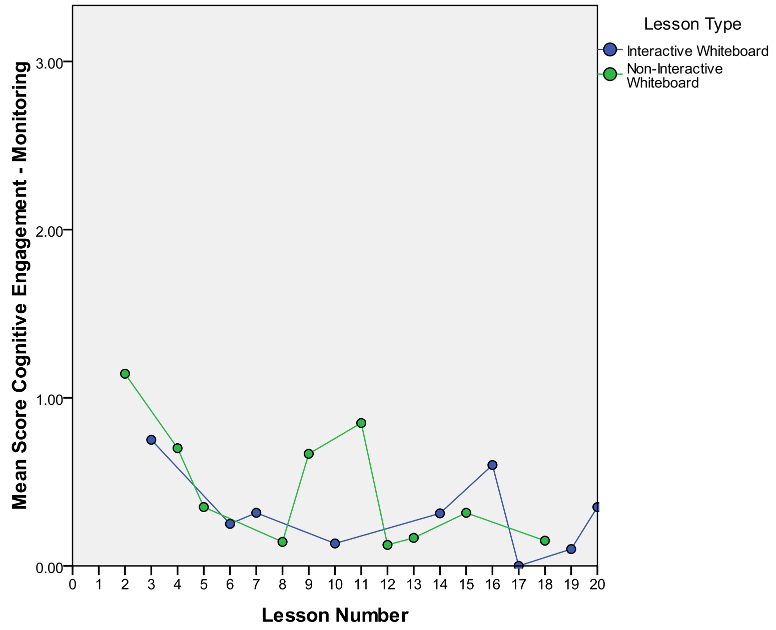


Figure 4-12
Jonathon: Average monitoring attempts per lesson
Monitoring: 3) with no prompting, self-corrects, asks relevant questions; 2) with prompting recognises error, some comments related to error and/or task. No relevant questioning; 1) with prompting, shows some recognition of error, but no clear connection or questions related to task; 0) no sign of self-correction, questioning, recognition of error.

The monitoring construct was scored when the student recognised an error and sought clarification by asking relevant questions, or self-corrected the error. The general level of monitoring behaviours were very low in both conditions, indicating that Jonathan rarely checked his answers for accuracy or may not have possessed the skills to do so without prompting from the researcher. The descriptive statistics shown in Table 4-6 and in Figure 4-12 show that there was little difference between the two conditions in the level of this activity, and there are many overlapping data points, so no clear difference in level of monitoring between the conditions could be established. The PND indicate a minimally higher monitoring rate in the non-IWB condition at 56%. The randomisation test analysis showed the probability value of a RSS value of 0.30, not statistically significant at α < .05 level.

It is relevant to note that the similarity in the level of monitoring behaviour emerged even though the IWB condition offered features that assisted Jonathon in monitoring his progress, such as letters ‘disappearing’ if they were incorrectly placed in the task space. The computer program, the Reading Doctor™, gave visual prompts that Jonathon became aware of, such as the human mouth saying the letter/word; and when a picture was not selected within a specified time frame, a picture prompt would appear. This picture prompt would be used by Jonathon to then select the appropriate word. He could also press on the individual letters to re-hear them before selecting an icon.

Problem Solving

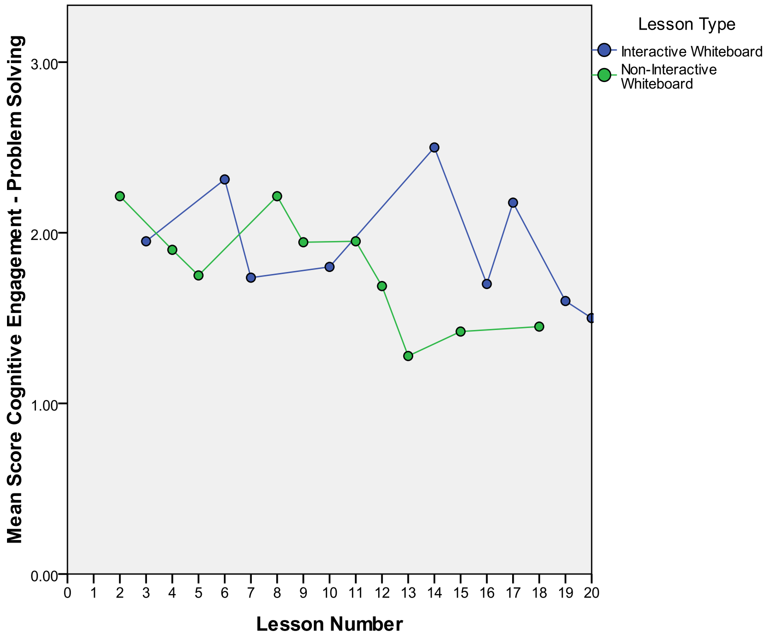


Figure 4-13
Jonathon: Average attempts at problem solving per lesson
Problem Solving: 3) carries out task spontaneously and accurately; 2) attempts on own, partially correct; 1) some progress with much assistance; 0) no progress or not required.

The problem solving element of cognitive engagement focused on Jonathon’s progress in solving the problems presented to him during a lesson. Judgements about the level of problem solving were made in terms of accuracy, and how much, if any, assistance was required to successfully complete a problem. Each lesson consisted of worked-examples (Sweller, 1999, 2005) and opportunities to practice the skill and solve the problems were presented.

The descriptive statistics for problem solving are depicted in Figure 4-13 and presented in Table 4-6. The level of the mean scores indicate that whilst Jonathon was attempting to solve the problems presented, he would make an attempt on his own, but was often unable to successfully complete the problem without assistance. The mean score for the IWB condition was 1.92 (range 1.50 – 2.50) and the non-IWB mean was 1.78 (range 1.28 – 2.21). The PND analysis (70%) indicated Jonathon was moderately more likely to problem solve independently in the IWB condition. The randomisation test analysis showed a RSS value of 0.39, which indicates no statistically significant difference between the conditions at $\alpha < .05$ level.

Skills or strategies that Jonathon used whilst attempting to problem solve were his listening skills to correct an answer (researcher prompt or Reading Doctor™ program prompt), and the use of picture clues to help decipher the word or sentence. He would look at the researcher's mouth or the Reading Doctor™ mouth as the sounds or words were being pronounced before attempting to solve the problem, and as time progressed he would say the word aloud and/or sound out the word with less prompting by the researcher. In many instances Jonathon would use the initial letter/sound as the cue and attempt to recall words he knew that started with that beginning sound. For example, if a word began with /b/, he would work through the words he had been introduced to, such as /bat/, /bag/ or /bug/, until he came to the correct answer. On the IWB he sometimes switched between screens to check the spelling of words, and then copied the appropriate letters into the immediate task. Whilst working in the non-IWB condition, Jonathon would problem solve by attempting to 'look through' flash cards to see what was printed on the other side.

Cognitive Load

Table 4-7
Jonathon: Number of rimes per lesson, number of target words per lesson and the introduction of new rimes

Lesson No.	1	2	3	4	5	6	7	8	9	10
IWB	NR				NR		NR			
sequence	L1	L3	L6	L7	L10	L14	L16	L17	L19	L20
No. rimes	1	1	1	1	2	2	2	1	3	3
No. words	4	4	4	3	7	6	9	5	12	12
Non-IWB	NR		NR			NR				
sequence	L2	L4	L5	L8	L9	L11	L12	L13	L15	L18
No. rimes	1	1	2	1	2	2	3	3	1	3
No. words	4	4	8	4	8	7	11	11	3	11

NR = new rime introduced

Across the two conditions, Jonathon was exposed to three rimes. In the non-IWB condition, he was introduced to the second rime a lesson earlier than the equivalent lesson in the IWB condition. This resulted in Jonathon having an additional lesson of all the sounds in the non-IWB condition than in the IWB condition. Table 4-7 depicts the number of rimes per lesson Jonathon was exposed to and when the new rimes were introduced.

Rimes were introduced across time, building small, cumulative steps to reduce cognitive load (Sweller, 2006). The rationale behind this approach was that through explicitly highlighting the rime, Jonathon (or the other students) could recognise the words presented had a common rime and the only variable was the onset letter. For example, when introducing c- at, b-at, m-at, s-at the researcher emphasised:

Researcher: [Whilst concealing the onset of all the presented words] *the last two sounds, /a/t/ make /at/*, *This is the same for all the words. Only the first letter changes, look, we have c-at, /cat/; b-at, /bat/; m-at, /mat/ and s-at, /sat/.*

The number of rimes Jonathon was exposed to were related to his performance in the previous session, or how he performed on the revision component of that day's session, resulting in a variation in the number of words he was exposed to from lesson to lesson, and condition to condition. For example in lesson 5 in the non-IWB condition he was introduced to the second rime and in the next non-IWB lesson (L8) he worked with only the new rime, before both rimes were incorporated into lesson 9.

Pearson's correlations were calculated to assess whether the number of rimes was associated with level of engagement (Sweller, 1988).

Table 4-8
Jonathon: Pearson's correlation comparing the relationships between number of target rimes presented and task, affective and cognitive engagement scores

	Task Engagement	Affective Engagement	Cognitive Engagement
IWB			
n=9	-.813**	-.812**	-.849**
Non-IWB			
n=10	-.397	-.162	-.541

**.Correlation is significant at the 0.01 level (1 tailed).

The correlations in Table 4-8 indicate that there were significant, strong negative relationships between engagement behaviours (task, affective and cognitive), and the number of rimes presented in the IWB condition, and low to moderate negative relationships in the non-IWB condition. Even though the number of data points upon which these correlations are calculated was relatively small, the difference in the strength of these correlations is striking, suggesting when the number of rimes were increased in the IWB condition, Jonathan was presented with a greater cognitive load than when the number of rimes increased in the non-IWB condition.

This negative relationship is not surprising, as the increase in the number of rimes presented would be expected to result in a corresponding increase in the cognitive load experienced by Jonathon. This increase in cognitive load would also be increased when presenting Jonathon with words that began and/or ended in the same letter/sound. Some component of this assumed increase in cognitive load seemed to be associated with the fact Jonathon repeatedly relied upon identifying words by the first letter, and towards the end of the sessions, he encountered more than one word with the same initial letter/sound, and so had to draw upon the taught skill of sounding and blending, thereby requiring more cognitive resources resulting in an increase in cognitive load.

There is a stronger negative relationship between the number of rimes presented and the elements of selection and elaboration in the IWB condition, suggesting that in the IWB condition an increase in the number of rimes presented impacts more strongly on the early stages of processing. In both the IWB and non-IWB conditions, the number of rimes presented strongly and negatively affected Jonathon's ability to problem solve successfully and independently.

Rime Acquisition

It could be argued that Jonathon learnt the rimes presented in the non-IWB lessons faster than in the IWB condition. He was introduced to the new rimes in lessons one, five and seven in the IWB condition and lessons one, three and six in the non-IWB condition. This gave Jonathon an additional lesson in the non-IWB condition in which he was exposed to the three rimes at the same time, exposing him to learning how to discern and identify differences between similar looking words; for example /nip/pin/.

Summary: Jonathon

The rule used to determine whether a difference between the two conditions was evident was where all three analyses were in the same direction in favour of one condition, a consistent difference was assumed; a favourable difference existed when two of three analyses were in the same direction; and no difference existed when one or none of the results were in favour of a condition.

Two major features of Jonathan's engagement behaviour emerged from this analysis. First, Jonathon showed consistently high levels of task and affective engagement, and a much lower level of cognitive engagement. Despite the lower level of cognitive engagement it is reasonable to suggest that he was engaged with the tasks in these lessons on sounding and blending. The findings on the individual elements of cognitive engagement suggest that this type of engagement may have constituted a limitation on the extent of progress he could make. Although he showed high levels of appropriate selection activity, the low levels of elaboration and monitoring, could be expected to limit the extent of productive transformation of newly presented reading knowledge.

Second, there was no consistent pattern of difference in the level of Jonathan's engagement between the two conditions, with the mean scores for each of the three components being at similar levels. Although Jonathan tended to show a higher level of task engagement in the IWB condition this pattern of difference was not evident for either affective or cognitive engagement ratings.

The summary table (Table 4-9) clearly identifies the lack of consistent difference in engagement between the two conditions, with the IWB being favourably more effective with task engagement, but no difference between the two conditions with affective or cognitive engagement.

Table 4-9
Jonathon: Summary of engagement behaviours

Type of Engagement Behaviours	Individual Engagement Elements	Visual Analysis	PND Effect	Randomisation Test	Summary
Task engagement		IWB > non-IWB	moderate IWB > non-IWB	no significance	in favour of the IWB
	Activity related	IWB > non-IWB	highly IWB > non-IWB	no significance	in favour of the IWB
	Eye contact	IWB > non-IWB	highly IWB > non-IWB	statistical significance IWB > non-IWB	highly significant effect IWB > non-IWB
Affective engagement		no visual difference	minimal < non-IWB	no significance	no difference
	Interest	IWB > non-IWB	minimal IWB > non-IWB	no significance	in favour of the IWB
	Mood	non-IWB > IWB	minimal non-IWB > IWB	no significance	in favour of the non-IWB
	Persistence	no visual difference	no relationship	no significance	no difference
Cognitive engagement		no visual difference	no relationship	no significance	no difference
	Selection	no visual difference	minimal non-IWB > IWB	no significance	no difference
	Elaboration	non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	minimal, significant effect non-IWB > IWB
	Monitoring	no visual difference	minimal non-IWB > IWB	no significance	no difference
	Problem solving	IWB > non-IWB	moderate IWB > non-IWB	no significance	in favour of the IWB

Cognitive engagement scores were noticeably lower in the individual elements of elaboration and monitoring, however when frequency of responses were analysed, a noticeable difference became apparent between the two conditions, where the non-IWB had many more responses than the IWB. The rate of relevant verbal elaborations is of importance as Jonathon has significant speech and language issues, and there is a need for him to practice and become confident in his ability to convey meaning and be understood. The ability to clearly enunciate sounds and words also has an impact on his ability to map the grapho-phonic sounds and symbols and to decode them when reading and writing. The verbal connections he made to his existing knowledge also help to establish stronger links and richer representations with grapho-phonic symbols. It would appear through the feedback provided by his class teacher that he was able to integrate the information presented with prior knowledge and apply the skill being taught when faced with novel reading situations.

Within the non-IWB condition, rimes were introduced earlier than the IWB condition (refer to Table 4-7), indicating that Jonathon was applying the sounding and blending skill to decoding words at a faster rate within the non-IWB condition. However, it cannot be determined as to whether this was due to the random clustering of lessons or the delivery (IWB v's non-IWB) of the lessons.

At the end of his involvement in the research Jonathon's classroom teacher indicated his confidence in the class had grown. For example, he had gone up a reading level, was using the skill of sounding and blending and was persevering longer with difficult work.

5. Martin

Martin, at the time of the intervention, was 7 years 5 months old, and had been attending school for two years or eight terms. He had been identified as having Global Developmental Delay and severe language delay prior to commencing school, but due to lack of places in a regional Special Class, was placed into a regular class for the first term of his schooling.

Lesson History

Martin was generally happy to come to lessons, and would often compete with a classmate to be the first student to work with the researcher. However, if he perceived his classmates were doing something more interesting, he would be reluctant to leave the room and participate in the activities or tasks in the research lessons.

Feedback from his class teachers indicated he found it difficult to concentrate for long periods of time and to participate in a variety of activities within lessons. The researcher and class teachers deemed it necessary for Martin to be involved in the lessons for the full 20 minute session, and attempt to complete at least two tasks within the lesson focussing on the same blending/sounding skill, and if he refused to continue with the tasks, he would then participate in listening to a story to ensure his behaviour did not result in him returning to the classroom early.

The average instruction time was 10.95 minutes across the two conditions, however, in the IWB condition Martin had three lessons under 10 minutes, two of which (L2 & 3) problems were encountered with the IWB such as calibration issues and the board 'flicking' on and off. In lesson 14, Martin 'played' with the activities on the board by drawing circles, ticking, deleting and dragging incorrect target words. In the non-IWB condition, only one lesson was less than ten minutes (L19), a lesson in which he was highly engaged in the first activity presented, but he then refused to move onto a new activity. It was swimming week, a week in which the whole school was involved in a Learn to Swim program, and he was distracted by the movement of classes preparing to go to, or returning from, the pool.

Pre-test and post-test reading task results

Table 5-1
Martin: Pre and Post test results

Word presented	Pre-test	Percentage correct	Post test	Percentage correct
vc		**100%**		**75%**
an	an	✓	an	✓
on	on	✓	on	✓
it	it	✓	if	X
is	is	✓	is	✓
cvc		**10%**		**50%**
ran	ran	✓	ran	✓
bed	ded	X	sounded d/e/d said /dad/	X
mop	run	X	mog	X
bin	i/b/n	X	bin	✓
leg			**led**	X
pat			pat	✓
dog			dog	✓
sad			sad	✓
pig			**pin**	X
fan			**fin**	X

On pre-test, Martin was presented with the 16 letters in random order both visually and verbally. He was successful at identifying these letters, therefore he was presented with the vc and cvc words generated from the set of 16 letters. Martin showed he was familiar with the process of blending, as he did lots of '*homework with mum'*, and blending was an activity they did together. However, familiarity had not transferred into knowledge. He was successful at rapidly decoding familiar vc words, but on encountering cvc words, he struggled. It appeared he had no reliable effective strategy for dealing with the unknown words, using either guessing or starting in the middle position. For example, /bin/ was sounded out as /i/b/n/ then a word was offered in response that was difficult to interpret. Testing stopped after four consecutive incorrect responses. His pre and post-test results are displayed in Table 5-1.

Based on the pre-test data it was decided the initial focus of the intervention would be to concentrate on left to right directionality, whilst introducing him to the rimes. Martin also displayed some confusion with /b/, /d/ and /p/, when presented in a written format, so some time was also spent on learning to differentiate between these letters.

At post-test, Martin attempted to use the sounding and blending skill taught across the twenty sessions. However, it appeared he was relying on memory to recall words rather than use the sounds to blend together and work out the word. Martin would sound out the letters of the cvc word and attempt to blend the sounds but he would recall a target word from across the sessions that began with the same sound. For example, he would sound /l/e/g/ and say /led/, /p/i/g/ = /pin/ and /f/a/n/ = /fin/, as highlighted in bold in Table 5-1. On occasions, Martin still encountered some difficulty with the grapho-phonic presentation of b/d/p, but from lesson 8 onwards the confusion between the letters was less evident, indicating he had made some progress distinguishing among the three.

Engagement

A feature of Martin's behaviour that affected his results was the impact of him making or perceiving to make an error on his levels of engagement across the three constructs. The impact of his error or perceived error making will be discussed within each section regarding task, affective and cognitive engagement behaviours.

Before discussing each of the constructs, an overall look at the means calculated across the three engagement behaviours and the correlations between the three engagement constructs will be presented.

Table 5-2
Martin: Means and Ranges for Engagement Behaviours

	Task Engagement Behaviours		Affective Engagement Behaviours		Cognitive Engagement Behaviours	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	1.84 (0.34)	1.21 – 2.27	1.69 (0.29)	1.24 – 2.15	0.69 (0.21)	0.36 – 1.07
Non-IWB	2.09 (0.43)	1.41 – 3.00	2.03 (0.33)	1.33 – 2.73	0.99 (0.21)	0.66 – 1.40

The means for the ratings of each of the engagement behaviour constructs are presented in Table 5-2. Across each of the types of engagement, the means were higher in the non-IWB condition. The range of scores identified in the non-IWB condition started higher, and depict a broader, more fluctuating range of scores than the IWB.

Table 5-3
Martin: Pearson's Correlations between the ratings for three engagement constructs of task, affect and cognition across the IWB and Non-IWB conditions

Lesson Type		Level of Affective Engagement	Level of Cognitive Engagement
IWB	Level of Task Engagement	.950**	.871**
N=10	Level of Affective Engagement		.925**
Non-IWB	Level of Task Engagement	.758**	.658*
N=10	Level of Affective Engagement		.492

** Correlation is significant at the 0.01 level (2 tailed)
* Correlation is significant at the 0.05 level (2 tailed)

The correlations among Martin's three engagement ratings, displayed in Table 5-3, signify that when he was positively engaged cognitively, he also tended to be positively engaged affectively and also with the task, irrespective of the type of lesson. The correlations were stronger in the IWB condition, particularly between the cognitive and affective engagement constructs.

The individual constructs of engagement are considered next, and within each construct the individual elements will be analysed in respect to their relationship to Martin's behaviour and how it relates to the research question of whether there is any difference in engagement levels between the IWB and the non-IWB conditions.

Task Engagement

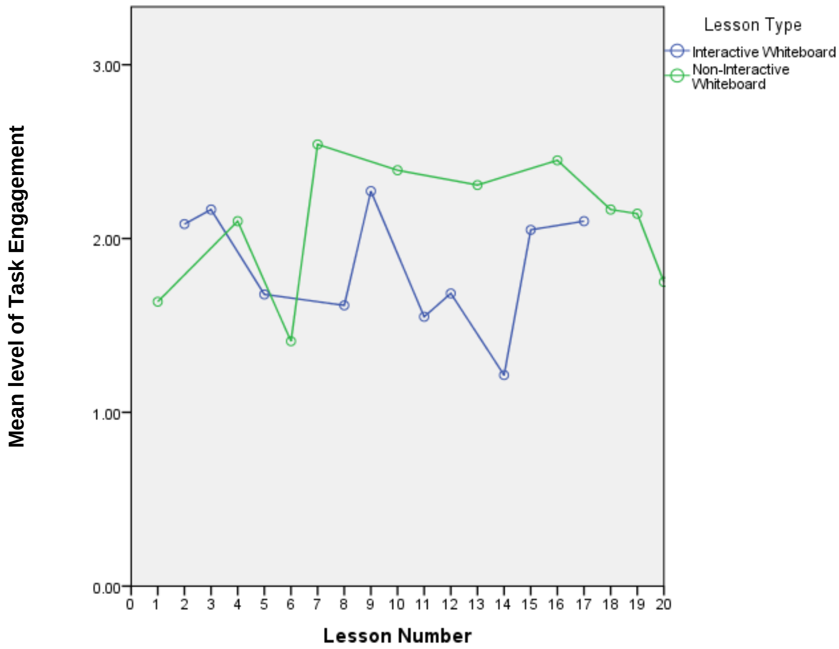


Figure 5-1
Martin: Mean Level of Task Engagement behaviours per lesson
Task engagement score: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

The profile represented in Figure 5-1, indicates Martin was mildly positively task engaged across most of the lessons, and he found the non-IWB condition to be more task engaging than the IWB. This profile is reflected in the descriptive statistics in Table 5-2 whereby the IWB condition averaged a task engagement score of 1.84 (range1.21 - 2.27) compared with the non-IWB score average of 2.09 (range 1.41 – 3.00). The PND of 60% indicated Martin was minimally more task engaged in the non-IWB lessons. The randomisation test analysis showed the probability value of a RSS value of 0.15, which does not indicate a statistically significant difference between the conditions at $\alpha < .05$ level. The trend in the IWB condition was slightly negative, while a slightly positive trend was seen in the non-IWB condition.

Effect of Errors on Task Engagement

Further analysis of Martin's task engagement behaviour identified that his engagement was affected by how much lesson time had passed before he made an error or encountered some difficulty. The earlier in a lesson Martin made an error or perceived he had made an error, the less task engaged he became, as he generally had trouble recovering from making an error in either condition. However, there were three occasions in which he re-engaged with the lesson. In lesson 10 (non-IWB), on completion of the lesson he commented '*This is hard work'* (error in the 7th of 14 recording intervals), and appeared to be very pleased with himself for finishing the task. The other two instances of re-engagement occurred in lesson 15 (IWB) whilst revising /at/ words (7th of 10 recording intervals) and lesson 16 (non-IWB) whilst revising /ed/ words (1st of 10 recording intervals).

In lessons one to three, Martin was more task engaged in the IWB condition. In these three lessons, Martin encountered an error further into the lesson, i.e. he had more time error-free on the IWB, therefore he was on task longer within those lessons. The same applied to the final IWB lesson (L17). Furthermore, when Martin could get half way through any lesson before making or perceiving he had made an error, his task engagement would score in the positive range, indicating that lesson structure and scaffolding to support his learning was vital to keeping him on task. A table showing the analysis of when an error occurred and Martin's reaction to the error can be seen in Appendix E.

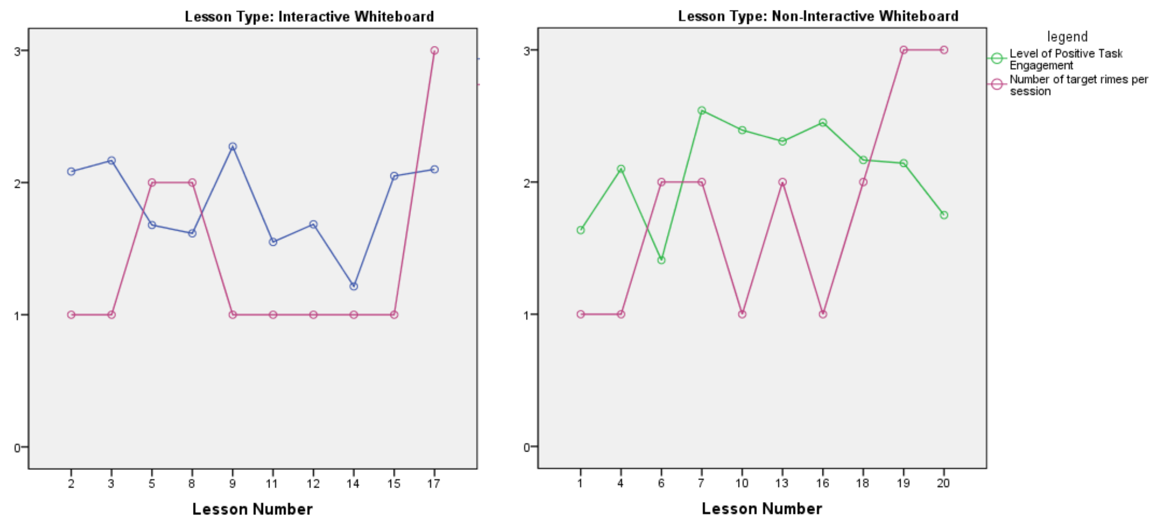


Figure 5-2
Martin: Task engagement and number of rimes per lesson per IWB and non-IWB conditions.

Figure 5-2 depicts the level of task engagement per condition in relation to the number of rimes taught in each lesson. Martin's task engagement behaviour in the IWB condition bore little connection to the number of rimes presented. The first two lessons of two rimes (L5 and L6) register a fall in task engagement with an obvious increase in the task engagement rating when the lesson was reduced to teaching one rime (L9). However, the following IWB lesson, lesson 11, had only one rime included, and Martin' task engagement rating fell and remained low until lesson 15. The final lesson in this condition, lesson 17 showed an increase in task engagement which was unusual considering that three rimes were included in this lesson, and it was the first time in either condition that he was exposed to all three rimes.

The non-IWB condition showed a more consistent pattern of falling task engagement when more than one rime was included in the lesson. Lesson 7, a lesson in which two rimes were taught, was the only one in which an increase in task engagement behaviour was observed. This pattern could suggest an increase in the cognitive load experienced by Martin in these lessons, making it more difficult to stay focused on the tasks at hand.

Cognitive load and its possible effect on Martin's capacity to remain engaged will be discussed near the end of this chapter.

The individual elements of task engagement will be considered next.

Individual Elements of Task Engagement

Table 5-4
Martin: Average Task Engagement Behaviours per lesson

	Task Engagement Behaviours – activity related behaviour		Task Engagement Behaviours – eye contact	
	M (SD)	Range	M (SD)	Range
IWB	1.74 (0.34)	0.86 – 2.18	1.95 (0.31)	1.57 – 2.36
Non-IWB	2.04 (0.37)	1.36 – 3.00	2.14 (0.39)	1.45 – 3.00

Table 5-4 presents the mean score per the individual elements and the range of scores as indicated by observing Martin's behaviour. The means indicate that activity related behaviour and eye contact were both higher in the non-IWB condition, with a mean of 2.04 (range 1.36 – 3.00) and 2.14 (range 1.45 – 3.00) respectively, compared to the IWB's mean of 1.74 (range 0.86 – 2.18) and 1.95 (range 1.57 – 2.36). The range of scores in the non-IWB condition across both elements was also higher than the IWB condition.

Activity Related Behaviour Eye Contact

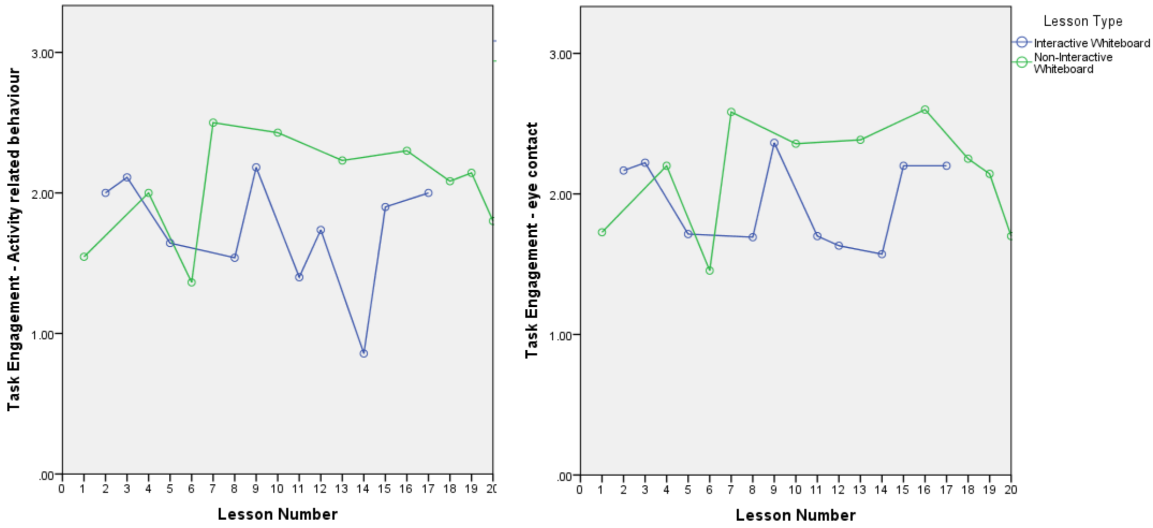


Figure 5-3
Martin: Average activity related behaviour and eye contact: Task engagement elements.

The visual inspection of the data in Figure 5-3 indicates Martin displayed more on-task behaviours in the non-IWB lessons in both activity related behaviour and eye contact. However, the PND results indicate a minimal preference towards the non-IWB condition with a PND of 66% in activity related behaviour and 55.6% in the eye contact element. The randomisation test analysis showed the probability value of a RSS value of 0.10 for activity related behaviour and 0.23 for eye contact. These scores indicate no statistical significant difference between the conditions at $\alpha < .05$ level for either element.

The individual results are consistent with Martin's avoidance behaviours that emerged once he encountered or perceived he had encountered an error. In the IWB condition, the features of the board provided him with easily accessible distractions, such as playing with the pen colour, pen width, style; erasing and deleting and ultimately closing the program or flipchart. Lesson 14 in the IWB condition showed this clearly. Martin encountered an error in the first minute of the lesson, and consequently spent most of the lesson ‘playing’ with the features of the board. See Figure 5-4 for a snapshot of Martin ‘playing’ with the board.

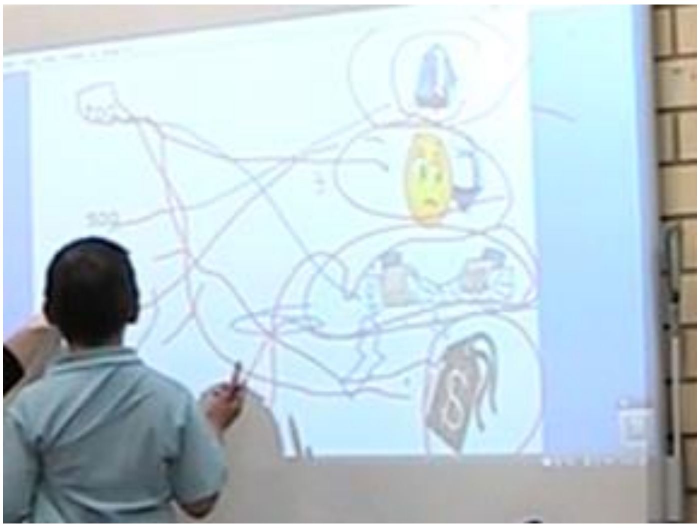


Figure 5-4
Martin: An example of Martin using the features of the board as an avoidance tactic

Affective Engagement

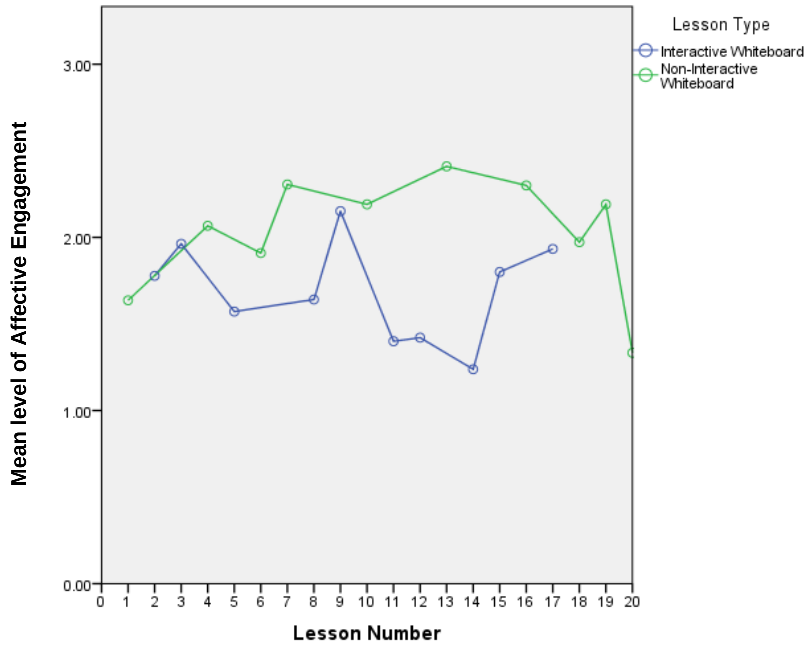


Figure 5-5
Martin: Mean Level of Affective Engagement Behaviours per Lesson
Affective engagement score: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

Affective engagement refers to the level of interest and emotion Martin brought to the lessons, as well as his ability to persevere in times of task difficulty. The overall affective engagement descriptive statistics in Table 5-2 and depicted in Figure 5-5 show that Martin's overall engagement fluctuated around the mildly, positively engaged level, indicating that he was often affectively engaged in the tasks but required some assistance with focussing when persistence was required. He was more affectively engaged in the non-IWB condition (mean 2.03, range 1.33 – 2.73) than the IWB condition (mean 1.69, range 1.24 – 2.15). The PND score analysis was moderately in favour of the non-IWB at 80%. The randomisation test analysis showed the probability value of a RSS value of 0.023, which does indicate a statistically significant difference between the conditions at $\alpha < .05$ level.

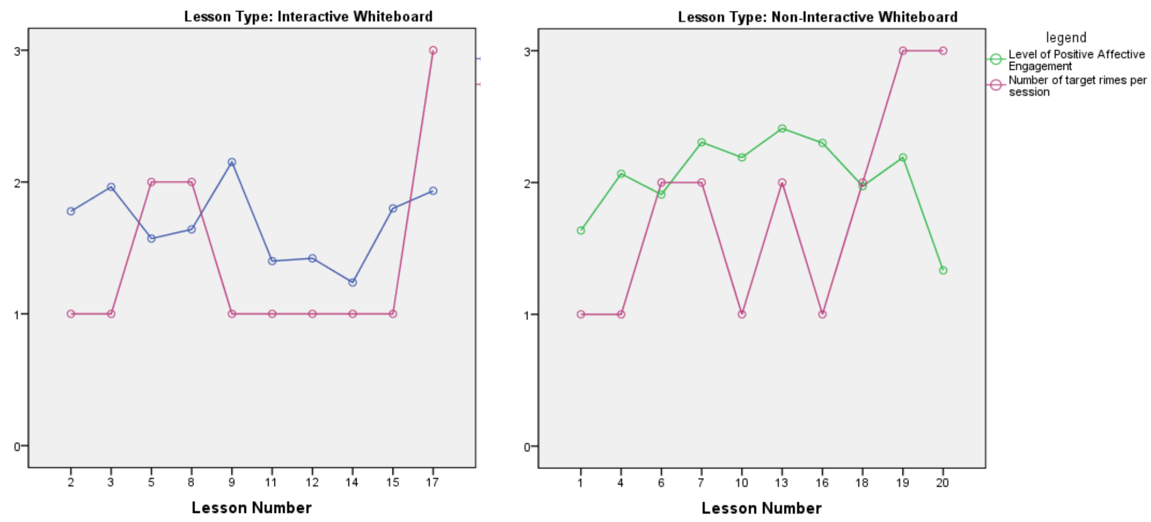


Figure 5-6
Martin: Affective engagement and number of rimes per lesson per IWB and non-IWB conditions

On each occasion that Martin was introduced to a new rime, a fall in his affective engagement was observed (See Figure 5-6; L5 and L11 IWB, L6 and L10 non-IWB). Consideration of the individual elements of affective engagement behaviours follows, with a more detailed analysis of the impact of introducing new rimes to the lessons.

Individual Elements of Affective Engagement

The overall Affective Engagement construct consisted of three elements; interest, mood and persistence.

Table 5-5
Martin: Average Affective Engagement Behaviours per lesson

	Affective Engagement Behaviours – Interest		Affective Engagement Behaviours – Mood		Affective Engagement Behaviours - Persistence	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	1.74 (0.37)	1.14 – 2.27	1.92 (0.14)	1.71 – 2.10	1.41 (0.41)	0.86 – 2.09
Non-IWB	2.07 (0.30)	1.64 – 2.60	2.12 (0.39)	1.20 – 2.60	1.90 (0.42)	1.10 – 3.00

Across the three elements, the means, presented in Table 5-5, were each higher in the non-IWB lessons than in the IWB lessons. The visual representations of the means are presented in Figure 5-7. The overall level of engagement was in the mildly positive range for interest and mood in both conditions, and for persistence in the non-IWB condition. Persistence in the IWB condition was in the negative to mildly positive range.

The PND analyses support the judgement of Martin's higher affective engagement whilst participating in the non-IWB lessons for each of the three elements. This reflects the conclusion emerging from visual inspection of the graphs in Figure 5-7. The randomisation test analysis indicated the probability value of a RSS value of 0.045, 0.14 and 0.023 for interest, mood and persistence, indicating a difference between the two conditions for interest and persistence at $\alpha < .05$, but no difference between the two conditions for mood.

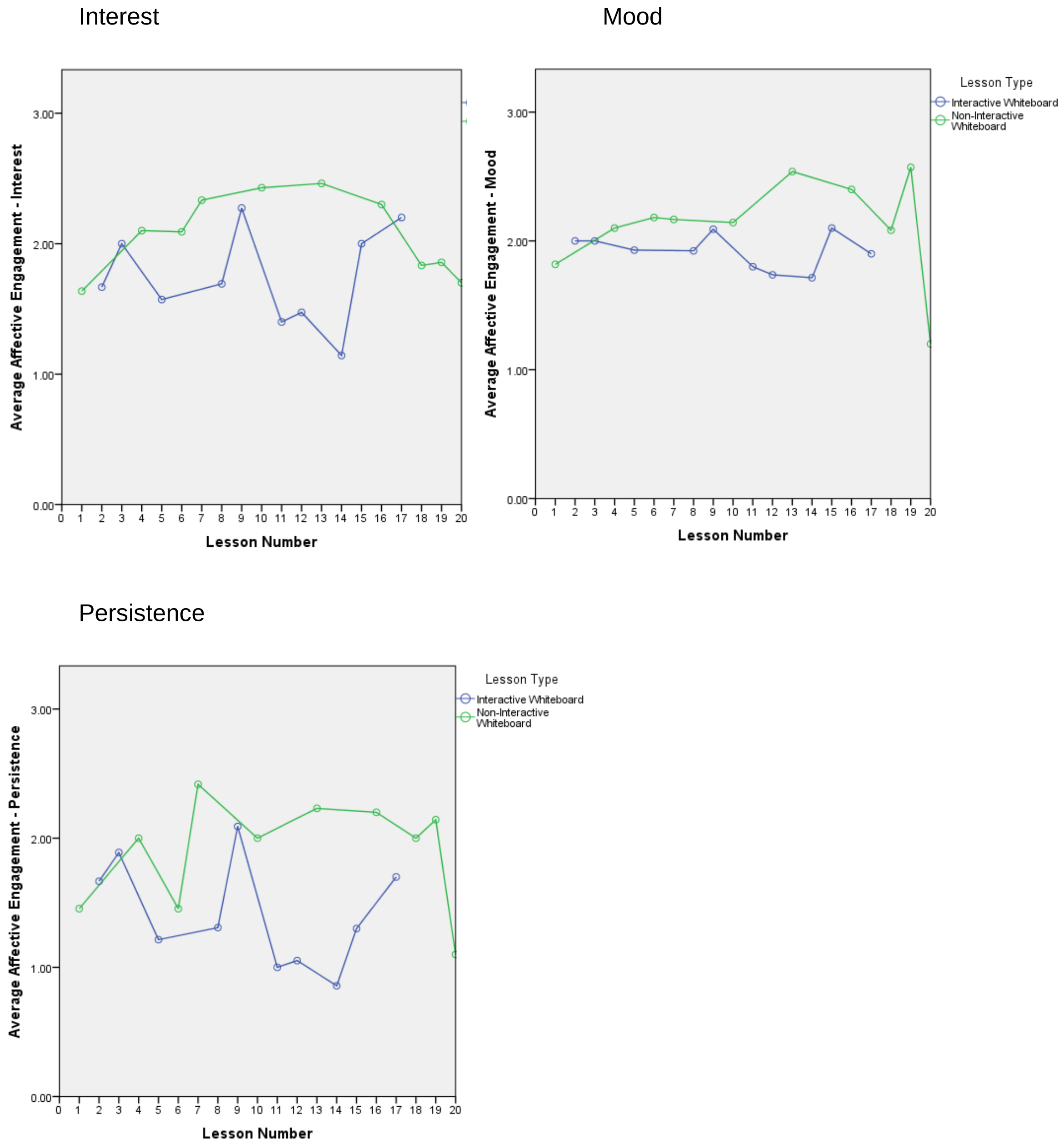


Figure 5-7
Martin: Average Interest, Mood and Persistence per lesson
Interest Scale: 3) shows sustained, intense interest; 2) shows some momentary, intense interest; 1) not upset, but lacks real interest; 0) sad, cries, pouts, angry, frustrated, tantrums. Mood Scale: 3) laughing appropriately, looking to interact with the teacher be part of the group; 2) smiling, looks pleased; 1) bored, expressionless; 0) child not enjoying self. Persistence Scale: 3) independently continued with focus activity, especially when faced with a difficulty/error; 2) attempted to continue on own, but required some assistance to continue with the focus activity; 1) made some effort to complete the focus activity with assistance, no effort when persistence required; 0) no attempt to complete activity when faced with an error/difficulty.

The element of interest showed a very clear drop in lessons 5, 11, 12 and 14. This drop was less evident with his mood but also apparent with the level of persistence displayed. In the fifth and eleventh lessons, Martin was introduced to a new rime, and encountered an error early in the lessons. During the twelfth and fourteenth lessons, he also encountered an error early in the lesson from which he did not recover (see Appendix E; Martin's Error Profile).

The graphs depicted in Figure 5-7 suggest that Martin's mood remained relatively unaffected by making an error, however, his ability to independently stay with a task and focus on how he may be able to overcome and solve a problem declined.

Cognitive engagement

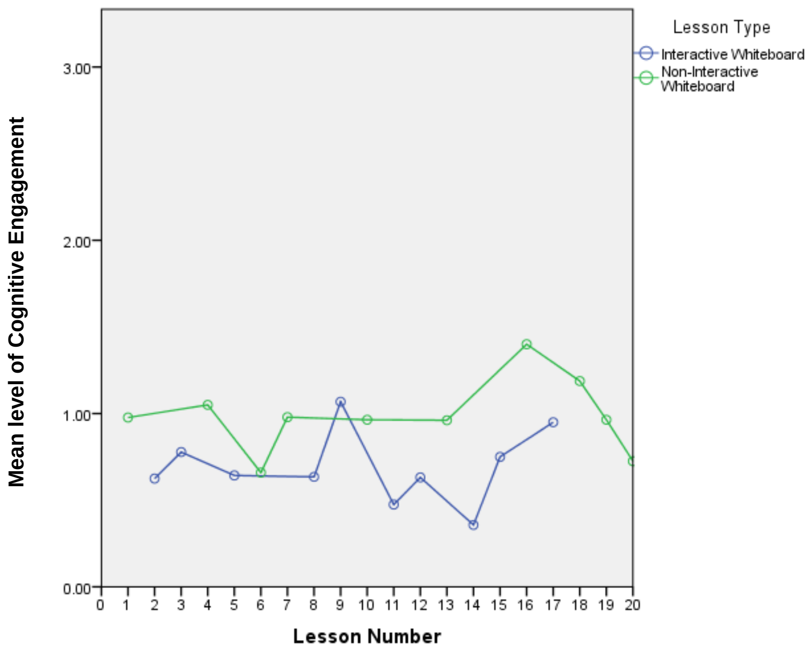


Figure 5-8
Martin: Mean Level of Cognitive Engagement Per Lesson.
Cognitive engagement score: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

Figure 5-8 presents the average cognitive engagement score per lesson for both conditions, Martin's cognitive engagement behaviours were in the low, mostly negative range, and the trend was relatively unchanged across time. The overall mean scores for cognitive engagement were again in favour of the non-IWB condition (mean 0.99, range 0.66 – 1.40) compared to the IWB condition (mean 0.69, range 0.36 – 1.07; see Table 5-2). The PND analysis of 80% indicated that cognitive engagement behaviours were moderately higher in the non-IWB. The probability value of a RSS score of 0.004 arising from the randomisation test analysis indicated a statistically significant difference between the conditions at α < .05 level.

Interactive Whiteboard   Non-Interactive Whiteboard

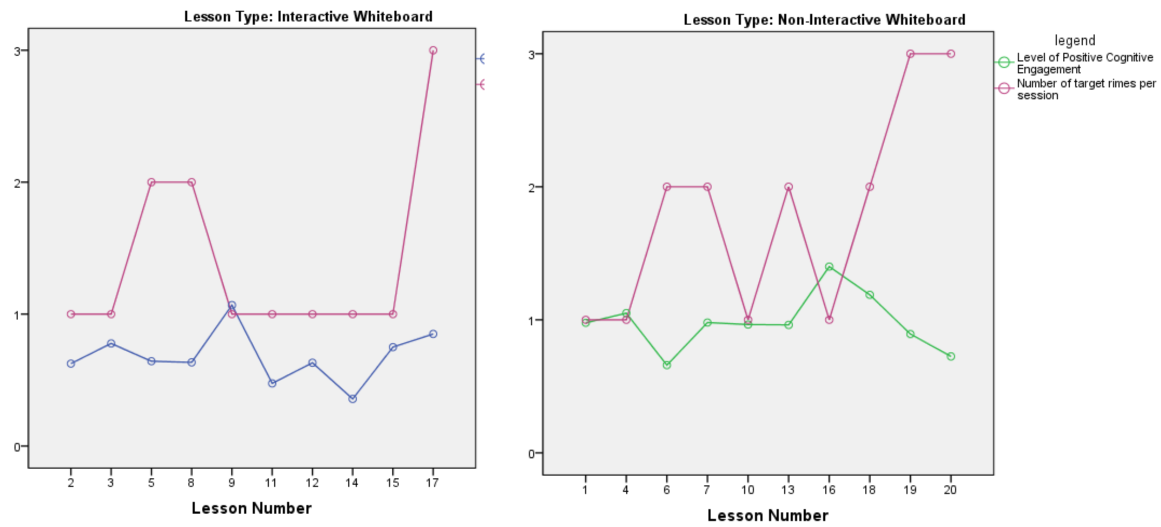


Figure 5-9
Martin: Cognitive engagement and number of rimes per lesson per IWB and non-IWB conditions

The introduction of a new rime in the IWB condition was consistently associated with a drop in cognitive engagement levels (L5 and L11; Figure 5-9). However, this pattern was not constant in the non-IWB condition where a fall in cognitive engagement can be observed in lesson 6, but no change in lesson 10 (Figure 5-9).

Individual Elements of Cognitive Engagement

Table 5-6
Martin: Average Cognitive Engagement Behaviours per lesson

	Selection		Elaboration		Monitoring		Problem solving	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	1.61 (0.49)	0.86 – 2.64	0.16 (0.17)	0.00 – 0.50	0.02 (0.07)	0.00 – 0.21	0.97 (0.27)	0.57 – 1.40
Non-IWB	1.98 (0.38)	1.27 – 2.80	0.42 (0.35)	0.00 – 1.10	0.05 (0.14)	0.00 – 0.45	1.51 (0.44)	1.00 – 2.20

Across the four elements that make up Cognitive Engagement, the means for selection showed a mildly negative to mildly positive engagement level; elaboration ranked in the very negative range. Almost no monitoring behaviours were observed, and the final element, problem solving, averaged in the mildly negative to mildly positive engagement behaviours (see Table 5-6). Each element will be discussed in more detail below.

Selection

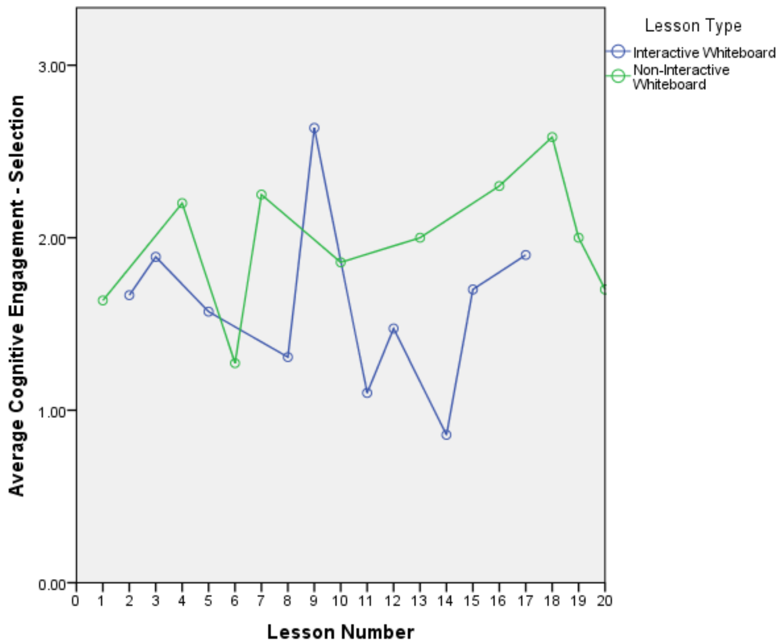


Figure 5-10
Martin: Average appropriate selection attempts per lesson
Selection Scale: 3) independently selects correct material to complete the task; 2) selects some or part of the material, but not enough to complete the task; 1) selects material, but inappropriate to the task; 0) no sign of selecting the material.

Figure 5-10 shows the variability Martin displayed in being able to independently select materials across lessons and conditions. In the non-IWB condition Martin was sometimes able to select the appropriate materials independently, but at other times required varying amounts of assistance. He was less likely to make the appropriate selection of material independently in the IWB lessons. These scores reflect Martin's behaviour, especially in the IWB condition where he was more likely to use the features of the IWB as tools of distraction rather than task completion tools.

The mean scores displayed in Table 5-6 show a preference towards the non-IWB condition (mean 1.98, range 1.27 – 2.80) when compared to the IWB condition (mean 1.61, range 0.86 -2.64). The divergence between the conditions occurs most dramatically when Martin made an error early in lessons 6 (non-IWB) 8, 11, 12 and 14 (IWB). The spike that occurred in lesson 9 (IWB) reflected a lesson in which an error occurred after 64% of the lesson had been completed. The observation of the error timing is important as it supports the previous discussion on the effect of error making during lessons, and Martin's ability to stay engaged with the task at hand if he could make it through half of the lesson without making or thinking that he had made, an error. When the PND analyses were calculated for comparable lessons, selection was minimally higher in the non-IWB condition in 67% of the lessons. The randomisation test analysis indicated the probability value of a RSS value of 0.026 for selecting, indicating statistically significant difference between the two conditions at $\alpha < .05$ level.

Elaboration

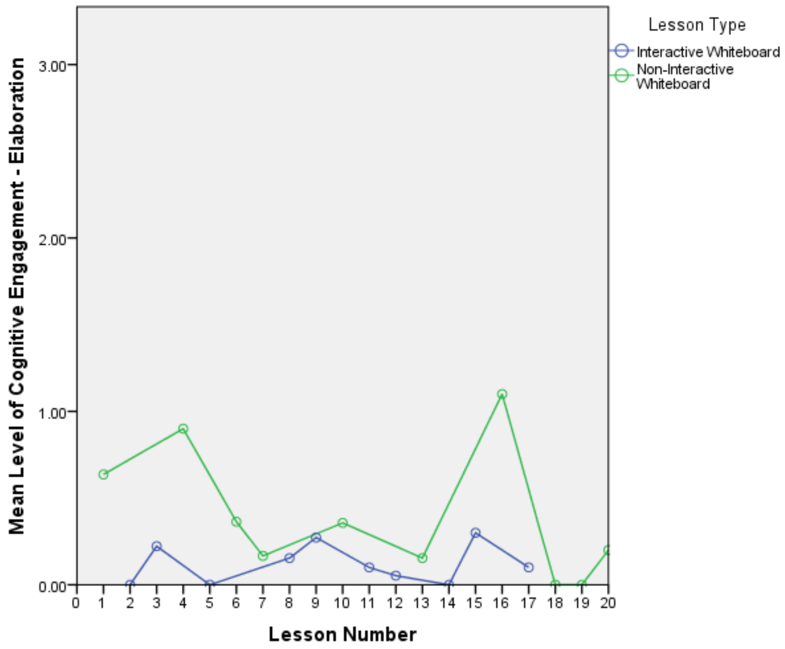


Figure 5-11
Martin: Average elaborated responses per IWB and non-IWB
Elaboration Scale: 3: independently connects material with an original elaboration, extends ideas, creates other relevant word. Can include non-verbal responses; 2: with or without prompting, connects material with previous learning; 1: with or without prompting, attempts to elaborate, but no clear connection with the material; 0: no sign of connecting material to prior learning.

Martin's overall level of elaboration was in the very low range, signifying that he made little attempt to connect the material to prior knowledge or if he did, such elaboration was not related to the task at hand.

The mean scores in elaboration were in the very negative range, especially in the IWB condition where a score of 0.16 (range 0.00 – 0.50) was recorded. The mean for the non-IWB condition was slightly higher at 0.42 (range 0.00 – 1.10). These scores support the observations made of Martin's responses, where he rarely connected the task at hand to his existing knowledge by expanding upon the theme or connecting the task to prior learning. He was however, more likely to attempt to connect the current task to learning in the non-IWB condition, where he more often expanded upon the meaning of the word to the researcher. For example, he indicated that he had '*fed the turtle'* in connection to the word /fed/ or recognise that

/dip/ is the same when turned upside down. Early error making in a lesson most often meant that no elaboration was attempted in either condition.

The PND (66%) analysis confirms the visual analysis (see Figure 5-11), suggesting that the IWB condition was less likely to produce elaborated responses, with only one of the comparable lessons, the final lesson, producing more elaborated responses than in the non-IWB lessons. The comparable non-IWB lessons were more likely to produce an elaborated response, a minimal difference. The randomisation test analysis showed the probability value of an RSS value of 0.04 indicating a statistically significant difference between the two conditions for elaboration at $\alpha < .05$ level.

Spontaneous, verbal utterances, a sub-element of elaborations made throughout the lessons will be further explored in the next section.

Verbal elaborations

Verbal elaborations were unprompted comments that Martin contributed to a lesson, and have been identified as being either irrelevant or relevant to the task. Irrelevant comments were responses Martin used which bore no connection to the task at hand and most commonly occurred after he had made an error. After error making, he would be asked a question to prompt him towards selecting an appropriate strategy to use to refocus his attention to the task. The goal of which was to guide him towards the desired answer. Relevant verbal elaborations were any discussions connected to the task at hand and involved accessing his existing knowledge. The occurrence of these responses is represented in Figure 5-12.

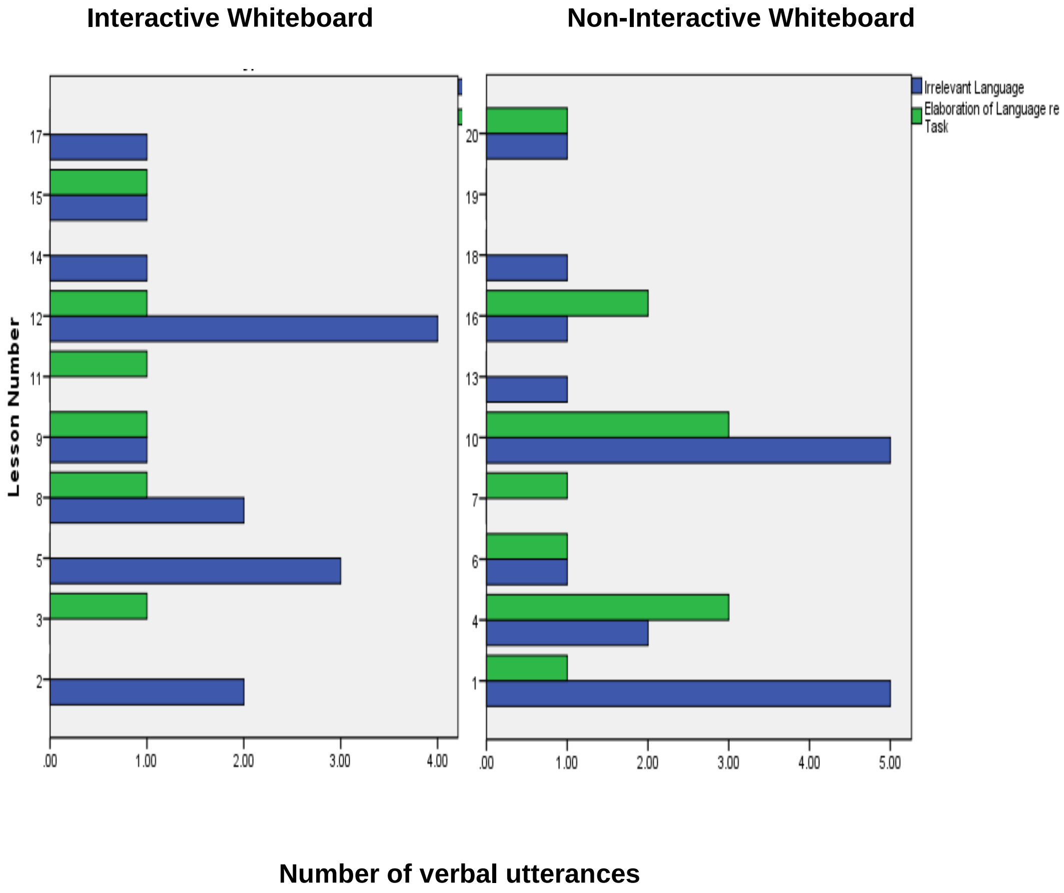


Figure 5-12
Martin: Occurrence of relevant elaborated language and irrelevant responses per condition and lesson
IWB frequency = 6 relevant, 15 irrelevant; non-IWB frequency = 12 relevant, 17 irrelevant

Martin used irrelevant language most commonly as an avoidance tactic, rarely responding to the questions put to him and trying to distract the researcher away from the task. For example, when on the IWB, he would ask irrelevant questions related to the stylus needed to activate the board such as *'Where's the other pen?'*, '*You got a wand here?'*; related to location '*Who's class is this?*'; or related to something other than the activity '*I can write Jim's (*pseudonym*) name'* and *'I can write it'*, '*I want to draw', 'I clean the page', 'I want to change the colour* (of the pen)'. Similar language transpired in the non-IWB condition such as, *'I want to write my name', 'What's that noise?', 'Who's office is this?', 'Hey, I need to (*sort pencils)'. When using the scissors to complete cloze exercises, the scissors would act as a prompt for very detailed, lengthy conversations such as '*Jim do this or* *not? Jim not use these scissors. I not cut myself. I been very careful. I like cutting with scissors, I like, cos mum said, I don't like sharp knife, only little knives. Sharp knives are for mum or adults, or for teachers';* irrelevant language would also be used to signal he had had enough *'It's time to go back', 'I tired*'.

Elaborated responses in the IWB condition consisted of connecting a letter to his name '*I got a /a/*'; voluntarily sounding a non-presented word '*/b/a/t/*' but not recalling the word itself; displaying his understanding of the word presented by using it in a sentence '*/sat/ on the mat'.* These elaborated responses were more common in the non-IWB condition and covered a range of knowledge (or not) such as, *'/d/ is for duck, /d/ is for goose'*, *'/i/n/, I found /i/n/*'; voluntarily matching cards *'/i/n/*', magnetic letters *'/i/n/*' and a magnetic fish *'/i/n/'* and then putting them together *'/i/n/, /in/';* to convey understanding *'You put the biscuits in (the dip). Mmmm (rubbing stomach) You can't lick your fingers, yuk!*'; '*Grandpa and Andrew were feeding the ducks'*, '*red, red'* whilst pointing to red objects around the room.

More spontaneous verbal responses were generated in the non-IWB condition, whether it was an elaboration of the task or irrelevant to the task. Only in lesson 19 (non-IWB) was there no instance of such responses. The occurrence of irrelevant responses was very similar in both conditions. However, the number of elaborated verbal responses recorded in the non-IWB condition was double the number recorded in IWB condition. This observation is important as the production of language continues to be necessary to develop understandings and communicative ability due to the dual nature of the disability – intellectual disability *and* severe language delay; keeping the language on task is the issue for the teacher.

Monitoring

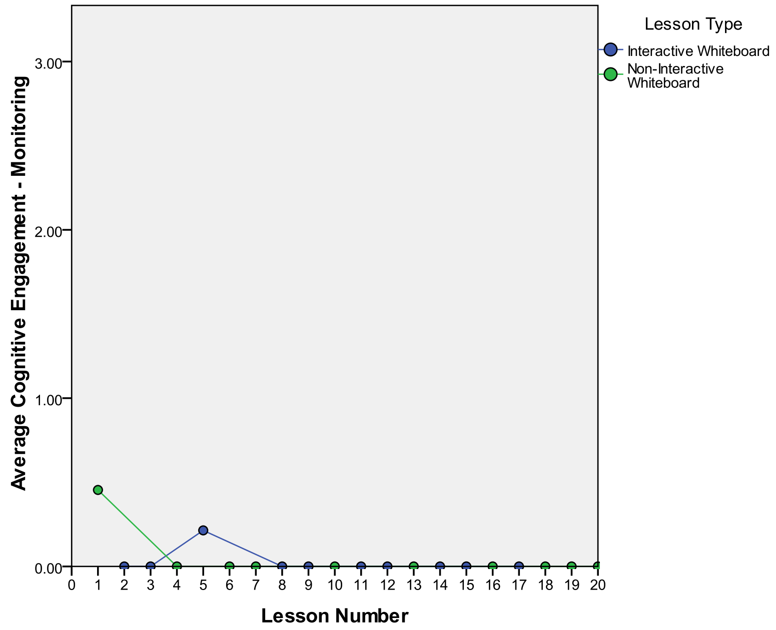


Figure 5-13
Martin: Average monitoring attempts per lesson
Monitoring: 3) with no prompting, self-corrects, asks relevant questions; 2) with prompting recognises error, some comments related to error and/or task. No relevant questioning; 1) with prompting, shows some recognition of error, but no clear connection or questions related to task; 0) no sign of self-correction, questioning, recognition of error.

The monitoring construct recorded activity when Martin recognised an error and either sought clarification by asking relevant questions, or made an attempt to self-correct the error. Both behaviours were seen as evidence of checking or monitoring of the current cognitive state or evaluation of the adequacy of a response.

As can be seen in Figure 5-13 and Table 5-6, Martin showed very little evidence of monitoring behaviour in either condition. In only two lessons, one in each condition, did he recognise and attempt to self-correct upon making an error. In the IWB condition, Martin recognised he had written a /d/ instead of a /g/, and realised he had placed the letters in the word /mat/ incorrectly, changing /mta/ to /amt/ (no further recognition or attempt to correct to /mat/). In the non-IWB condition, he recognised a letter was upside down and re-orientated it, and also recognised the letters /fni/ were out of sequence and changed them without prompting by the researcher.

The randomisation test analysis indicated the probability value of a RSS value of 1.0, showing no difference between the two conditions at α < .05 level.

Problem Solving

The problem solving construct focused on Martin's progress with a problem in terms of accuracy, and how much, if any, assistance was required to successfully complete a problem.

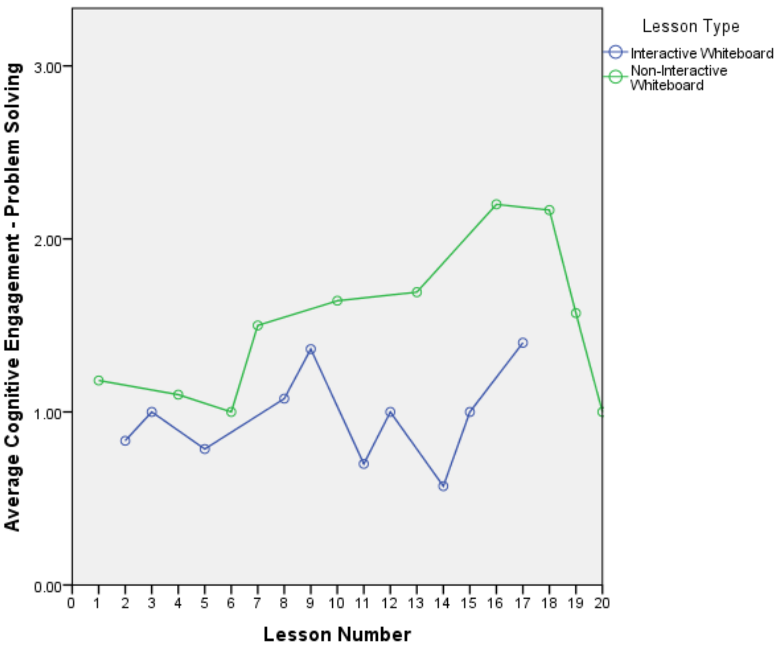


Figure 5-14
Martin: Average attempts at problem solving per lesson.
Problem Solving: 3) carries out task spontaneously and accurately; 2) attempts on own, partially correct; 1) some progress with much assistance; 0) no progress or not required.

On average, Martin invested very little effort towards independently solving problems presented in the IWB condition, with an average score for problem solving of 0.97 (range of 0.57-1.40). His problem solving efforts tended to vary around the indicator of 'some progress or effort with much assistance', whereas in the non-IWB condition, he averaged a score of 1.51

(range 1.00-2.20) and was trending upwards, towards ‘attempting on his own, partially correct’ (refer to Table 5-6). The PND analysis was moderately in favour of the non-IWB condition at 80%. The probability value of a RSS value of 0.0035 arising from the randomisation test analysis indicated a statistically significant difference between the two conditions for problem solving at $\alpha < .05$ level.

As depicted in Figure 5-14, Martin was more likely to attempt to problem solve with less prompting or assistance in the non-IWB condition. Across the ten lessons, he became more self-reliant in this aspect, showing increased effort, until the final lesson where he was asked to read a story containing all the words. In this lesson, Martin found the volume of words in the story difficult to attend to. Three minutes into the lesson, he was complaining of ‘*too many words’*. Essentially after three and a half minutes, Martin had given up, was guessing words, and using the pictures in an attempt to read the story. After five minutes he announced ‘*I’m tired of doing this’*. In an effort to finish the book, and check his knowledge of the target words, the researcher read the non-target words and Martin read the target words. He was compliant in doing this, but did complain of the book being ‘*too hard’*.

The skills Martin utilised to problem solve were to look at the researcher for cues, particularly the researcher’s mouth for letter or word formation, to rely on picture prompts to ‘read’ words and to look at the initial letter of the presented word and guess. Although he did use sentences to provide contextual information and cues from the picture and initial letter of the words presented, he consistently needed to have his gaze redirected towards the word or letters for example, ‘*Martin, you need to look at the word/the board/the paper*’.

Cognitive Load

Table 5-7
Martin: Number of rimes per lesson, introduction of new rimes and comparable lessons

Lesson No.	1	2	3	4	5	6	7	8	9	10
IWB	NR		NR			NR				
Sequence	L2	L3	L5	L8	L9	L11	L12	L14	L15	L17
No. rimes	1	1	2	2	1	1	1	1	1	3
No. words	4	4	8	8	4	5	4	4	4	11
Non-IWB	NR		NR		NR					
Sequence	L1	L4	L6	L7	L10	L13	L16	L18	L19	L20
No. rimes	1	1	2	2	1	2	1	2	3	3
No. words	4	3	7	7	3	6	3	6	10	10

NR = new rime introduced

Martin was introduced to three rimes in each condition. Table 5-7 displays when the new rimes were introduced (NR) and the number of rimes Martin was exposed to each lesson.

In an attempt to keep Martin engaged in the lessons, and reduce cognitive load, most lessons were kept to one or two rimes per lesson. When two rimes were in a lesson, they were presented separately so Martin was not required to distinguish between the two at any one time until the final lesson in each condition in which he was exposed to stories with all the rimes, for that condition.

Table 5-8
Martin: Pearson's correlation comparing the relationship between the number of target rimes presented and task, affective and cognitive engagement scores

	Task Engagement	Affective Engagement	Cognitive Engagement
IWB			
n =10	.060	.177	.314
Non-IWB			
n = 10	.155	.016	-.157

*. Correlation is significant at the 0.05 level (I tailed)

**. Correlation is significant at the 0.01 level (1 tailed).

For completeness of the findings, the correlations between engagement scores and number of rimes are shown in Table 5-8. However this analysis is not one of major practical significance. Seven of the ten lessons in the IWB condition did not exceed one rime because Martin would become frustrated, resulting in him playing with the features of the board, rather than attempting the task presented. In the non-IWB condition, four of the ten lessons focused on just one rime. The decision to expose Martin to one rime across the majority of lessons was made in an attempt to keep him on task for longer periods of time. None of the correlations between number of rimes and engagement scores were significant, indicating that no relationship existed between the number of rimes presented to Martin and task, affective and cognitive engagement (see Table 5-8).

Rime Acquisition

There was a one lesson difference in the introduction of the final rime between the two conditions, with the final rime being introduced one lesson earlier in the non-IWB lessons. Martin struggled to work with more than one rime at a time during lessons which led to him having trouble discerning between the more similarly looking words (for example bag/bug) as he would become overwhelmed and engage in avoidance behaviours, resulting in less lesson time spent on learning and attempting to apply the necessary strategies to sound, blend and decode the words presented.

Summary: Martin

Table 5-9
Martin: Summary of engagement behaviours

Type of Engagement Behaviours	Individual Engagement Elements	Visual Analysis	PND Effect	Randomisation Test	Summary
Task engagement		non-IWB > IWB	minimal non-IWB > IWB	no significance	in favour of the non-IWB
	Activity related	non-IWB > IWB	minimal non-IWB > IWB	no significance	in favour of the non-IWB
	Eye contact	non-IWB > IWB	minimal non-IWB > IWB	no significance	in favour of the non-IWB
Affective engagement		non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	moderate, significant effect non-IWB > IWB
	Interest	non-IWB > IWB	high non-IWB > IWB	statistical significance non-IWB > IWB	highly effective, significant effect non-IWB > IWB
	Mood	non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB
	Persistence	non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	moderate, significant effect non-IWB > IWB
Cognitive engagement		non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	moderate, significant effect non-IWB > IWB
	Selection	non-IWB > IWB	minimal non-IWB	statistical significance non-IWB > IWB	minimal, significant effect non-IWB > IWB
	Elaboration	non-IWB > IWB	minimal non-IWB > IWB	statistical significance non-IWB > IWB	minimal, significant effect non-IWB > IWB
	Monitoring	no visual difference	no relationship	no significance	no difference
	Problem solving	non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	moderate, significant effect non-IWB > IWB

Where all three analyses were in the same direction in favour of one condition, a consistent difference was assumed; a favourable difference was identified when two of three analyses were in the same direction; and no difference was indicated when one or none of the results were in favour of a condition.

The comparison of analyses presented in Table 5-9 across the three constructs of task, affective and cognitive engagement behaviours indicate Martin consistently showed higher levels of engagement in the non-IWB condition. He also produced more elaborated language responses in the non-IWB condition. This latter finding is noteworthy considering he also has a severe language delay. These spontaneous elaborations are an important feature of a lesson as they provide information to the class teacher about what connections Martin has made to the new lesson content, allow him to practice his speech, and to convey meaning verbally. His speech output was also an indicator of his on-task behaviour, as it became evident across time that Martin used language as an avoidance tactic when faced with tasks he perceived as difficult or after he perceived he had made an error.

The preference towards the non-IWB may have been due to less distractible features/objects available to him in that condition. In the IWB condition, on three occasions Martin 'took control' by closing the computer program and once deleting the page he was working on. On all other occasions he would play with the other accessible features of the board. In the non-IWB condition he was sitting in a seat next to the researcher, where he was less able to 'shut' the task down, although he was more prone to fiddle, slouch in his chair or protest verbally. It was also easier for him to find an alternative task in the non-IWB condition as paper and pencils were always at hand, rather than having to wait for the computer to re-load a program in which a similar activity could be produced, time in which Martin would become occupied by the broader classroom space in which the lesson was occurring.

The impact of an error was a noteworthy feature in Martin's case. Once Martin made an error, he was generally 'lost' to the task and would produce task avoidance behaviours rather than persevere with trying to problem solve. With lesson content and/or activities he was familiar with, he did show he was capable of re-engaging with the lesson and scoring positively on the engagement scale. This analysis also identified that when Martin was successful for at least half of the lesson time, he was able to positively engage with the lesson.

One key area of concern is the low levels of cognitive engagement displayed by Martin, as this would be predicted to have a significant negative impact on his ability to transform lesson information into knowledge. Developing the skills to self-monitor and reflect on problem solving attempts and to persevere with an activity when a problem is encountered is vital if Martin is to learn new information and expand his knowledge base. By not attempting to elaborate upon answers or monitor his responses, persevere when encountering an error, he will not change the store of knowledge he has about the lesson focus.

6. KRIS

Kris, at the time of instruction was 7 years 4 months of age and had been at school for nine terms. Four terms, or a full school year, were spent in a mainstream setting, however, when a vacancy arose, Kris moved into a special class setting where he had completed five terms of schooling. Kris had been identified with Global Developmental Delay and severe language delay.

Lesson History

Generally, Kris happily came to school, but he did have trouble separating from his mother most mornings, resulting in tears and a reluctance to participate in activities. This separation difficulty had some impact on the lessons in the project, particularly if his mother had not left prior to the researcher collecting him for the lesson. On one occasion, lesson 5, his mother and sister attended the lesson due to his separation anxiety. In lesson 16, Kris was very unhappy about his mother being unable to drop him at school due to illness in the family. During the setting up of lesson 16, and between tasks, he would state '*I want mum'*. From lesson 17 to lesson 20, his mother and sister were both struck down with an illness, resulting in them being hospitalised. This impacted negatively on Kris' general mood when arriving at school, and although he did not miss any school, he may have been more anxious during these times.

When Kris was on-task, he generally completed the activities quickly, and would complete three to five activities per lesson. As a result, Kris's lessons averaged 12.6 minutes in length, ranging between 7 - 20 minutes. One IWB lesson was under ten minutes due to technical problems with moving between the internet and the desk top program (L7), while the non-

IWB condition had two lessons less than ten minutes in length. During lesson 11, Kris was distracted by the book fair in the library and the number of people visiting the library, however, in this lesson he brought a class reader with him to show the researcher how well he could read; a vast change from lesson 9 in which he declared '*I can't read!*' In lesson 17 he took some time to settle into the lesson, possibly due to his mother and sister being unwell.

The video data for lesson 13 was unable to be interpreted due to the footage not downloading successfully. Therefore, the IWB data consisted of nine lessons overall, while the non-IWB condition contains all of the 10 sessions.

Pre-test and post-test results

Table 6-1
Kris' Pre and Post test results

Word presented	Pre-test	Percentage correct	Post test	Percentage correct
vc		**75%**		**100%**
an	at	X	an	✓
on	on	✓	on	✓
it	it	✓	it	✓
is	is	✓	is	✓
cvc		**0%**		**50%**
ran	when	X	ran	✓
bed	big	X	**fin / dip**	X
mop	man	X	mop	✓
bin	it	X	**dip** / dig	X
leg			leg	✓
pat			pit	X
dog			**dip**	X
sad			sad	✓
pig			pig	✓
fan			**fin**	X

Kris' pre-and post-test results are presented in Table 6-1. On pre-test, Kris successfully identified three of the four vc words presented after identifying the 16 letters presented in print and in aural form. However, when presented with cvc words, Kris was unsuccessful with the first four words in the list, therefore testing ceased. He did attempt to read the words, and offered two words that began with the initial sound of the words presented;

/big/ for /bed/ and /man/ for /mop/. He was unfamiliar with the concept of sounding and blending.

On post-test, Kris was able to read all of the vc words, but the cvc words still challenged him. Initially, he identified the initial and final letter/sound and would guess a word i.e. /pit/ instead of /pat/; or try to apply the words he had learnt over the twenty sessions i.e. /dip/ for /dog/, /fin/ for /fan/ (highlighted in bold in Figure 6-1). However, when reminded to sound out and blend the letters of the words presented, he successfully read five of the ten untaught cvc words.

Engagement

Engagement behaviours could not be coded for lesson 13, an IWB lesson, as the video file was corrupted and unable to be used in the analysis.

The means for the engagement behaviours across the three engagement constructs are shown in Table 6-2 and are all slightly higher in value in the IWB condition than the non-IWB condition.

Table 6-2
Kris: Means and Ranges for Engagement Behaviours

	Task Engagement Behaviours		Affective Engagement Behaviours		Cognitive Engagement Behaviours	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.51 (0.46)	1.68 – 3.00	2.29 (0.46)	1.59 – 2.80	1.40 (0.21)	1.08 – 1.61
Non-IWB	2.31 (0.50)	1.36 – 3.00	2.14 (0.50)	1.24 – 2.82	1.36 (0.24)	0.86 – 1.73

Kris' pre-lesson behaviour in six of the ten non-IWB lessons was reflected in the means, and possibly resulted in the greater variance in the range of scores in the non-IWB condition. For example, when he realised he would not be accessing the IWB, he would comment about wanting to go on the IWB, and it would take him longer to settle into the lesson. However, once focused on the task at hand, he would generally remain so for the length of the lesson. In lesson 4, the first non-IWB lesson, he commented '*I want to go on the whiteboard. … But I want to go on the whiteboard and play that game* (Reading Doctor™)*'.* In lessons 11, 16, 17, 19 and 20 he also displayed discontent about not using the IWB. In lesson 17 Kris refused to sit at the table, in lesson 19 he attempted to get the researcher's laptop out of her bag to connect to the IWB, and in lesson 20 he turned on the desk top computer and needed to be enticed to conduct the lesson off the computer. 'If you do …, then you can …'. The enticement needed to be restated during the lesson.

Table 6-3
Kris: Pearson's correlations between the three engagement constructs of task, affect and cognition across the IWB and non-IWB conditions

Lesson Type		Level of Affective Engagement	Level of Cognitive Engagement
IWB	Level of Task Engagement	.955**	.883**
N = 9	Level of Affective Engagement		.821**
Non-IWB	Level of Task Engagement	.980**	.942**
N = 10	Level of Affective Engagement		.938**

**. Correlation is significant at the 0.01 level (1-tailed).

The correlations shown in Table 6-3 indicate there were strong, positive correlations among task, affective and cognitive engagement in both conditions. This suggests that when Kris was positively task engaged in an activity, he was also positively affectively and cognitively engaged, irrespective of whether the lesson was on the IWB or not. All results were statistically significant.

Task Engagement

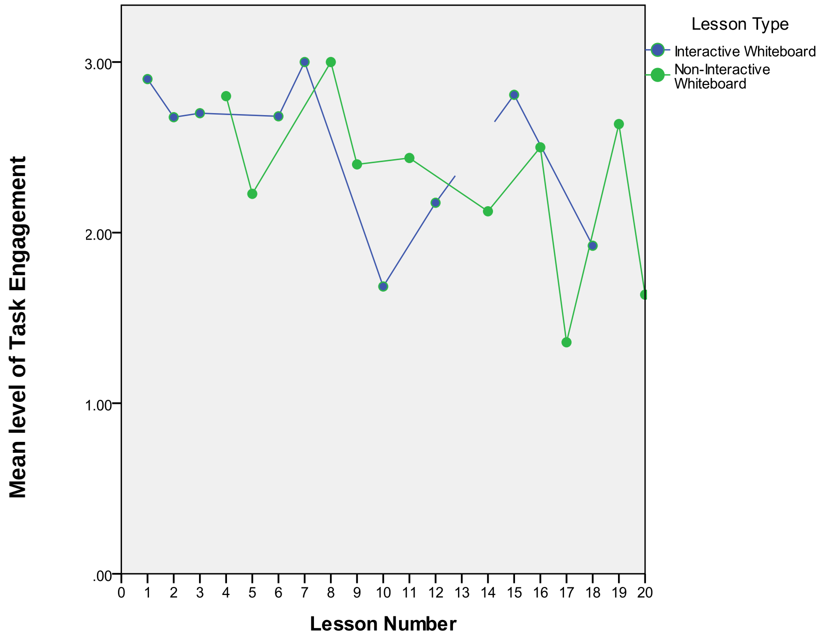


Figure 6-1
Kris: Mean level of task engagement behaviours per lesson
Task engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

Figure 6-1 displays the mean for task engagement per lesson, across the two conditions. Despite Kris stating his preference towards using the IWB, his average level of task engagement behaviour in the non-IWB condition was in the mildly to mostly engaged behaviour range, scoring a slightly lower mean than in the IWB condition. The mean scores, presented in Table 6-2, indicate the IWB condition mean was 2.51, ranging between 1.68 - 3.00, while the mean score in the non-IWB condition was 2.31, with a wider range of 1.36 - 3.00. The trend in both conditions was negative across time. PND analysis indicated that the effect of the IWB was in the minimally effective range at 67%, reflected in the overlapping data observable in Figure 6-1, while the randomisation test analysis showed no statistically significant difference between the two conditions with a RSS value of 4.99 at $\alpha < .05$ level.

Kris' task engagement behaviours declined towards the tenth lesson in each condition, moving from mostly positive engagement behaviours towards mildly negative behaviours. This fall in task engagement corresponded with the increasing number of rimes and words Kris was exposed to, the increasing complexity of the words presented, i.e. words beginning with the same letter and sound such as /bat/, /bag/ and /bug/, requiring a greater concentration to discriminate the differences between the words and produce the correct response, and his rising anxiety levels due to his mother's illness.

The highest recorded task engagement on the IWB was the fifth lesson (L7) in which the new rime /ug/ was introduced. In this lesson Kris successfully played an internet spelling game. However, after this game, there was a technical difficulty when changing programs and the lesson was forced to stop after seven minutes. This was the shortest lesson encountered in the IWB condition.

Lesson 10, sixth on the IWB, and the second lesson of the third rime, saw a drop in task engagement from an average score of three in the previous lesson to an average of 1.68. He spent much of the time playing with the width of the pen/highlighter tool and also changing the colour. These behaviours were most likely intentional behaviours, with the goal to distract the researcher and avoid having to complete the set task. Other times, Kris would 'guess' words presented by sounding out what was written, then answer with a previously learnt word. For example, he would sound out /r/u/g/ and produce words that he knew started with /r/ such as /rip/ and /road/. These guessing behaviours were more a reflection on avoidance strategies employed in the classroom to provide an answer to a problem without necessarily thinking about the situation, strategy or correct response.

Lesson 18 was also a low point in task engagement on the IWB, the lesson where Kris was presented with a story containing all the words learnt in the IWB condition. He attempted to delete the flipchart twice after he was informed that he would be reading a story.

The first lesson in the non-IWB condition Kris opened with '*I want the whiteboard*'. However, after a brief chat to let him know we would be using both across time, he settled into the lesson, and stayed on task. Kris' on-task behaviour in the non-IWB condition peaked in lesson 8, the third lesson on the sound /in/. He found most tasks relatively '*fun'*, and asked if we could play the fishing game '*always*'.

In non-IWB lessons 17 and 20 Kris was least task engaged. It was at this time that his mother and sister were ill, and he was having difficulty settling into school with his usual routine being disrupted. In lesson 20 Kris was asked to read a story with all the words learnt in the non-IWB condition. Kris preferred to go on the computer (not the IWB), turning the desk top computer on as soon as he realised he would not be using the IWB. The library was also very noisy that morning, with a new Reception class (4 ½ - 5 year olds) having a transition visit to the school. On presentation of the story, Kris flicked through the pages and declared '*no*, *it's big'*.

Interactive whiteboard Non-interactive whiteboard

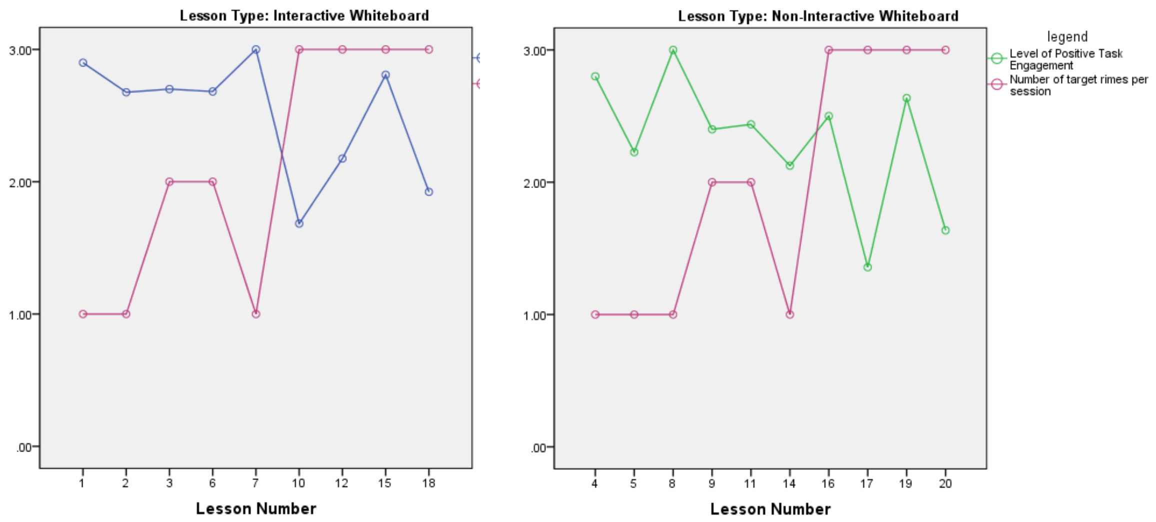


Figure 6-2
Kris: Task engagement and number of rimes per lesson per IWB and non-IWB conditions

Figure 6-2 shows task engagement scores across the IWB and non-IWB conditions alongside the number of rimes presented. Kris' task engagement behaviour fluctuated across the lessons, and a negative trend towards the final lesson was depicted in relation to the increasing number of rimes presented. This decline in task engagement across time could be indicative of the increasing cognitive load being placed on Kris. However, in both conditions there was a positive spike in the second to last lesson in which all three rimes were presented, lessons in which only the target words were presented, not target words in sentences, therefore reducing cognitive load. The final lesson in both conditions had stories which included the target words, the result in task engagement was a fall into the negative range.

The IWB graph is missing the data for lesson 13, a lesson in which Kris was also exposed to three rimes but in which the equipment did not function properly.

Individual Elements of Task Engagement

Table 6-4
Kris: Average Task Engagement Behaviours per lesson

	Task Engagement Behaviours – activity related behaviour		Task Engagement Behaviours – eye contact	
	M (SD)	Range	M (SD)	Range
IWB	2.48 (0.50)	1.58 – 3.00	2.53 (0.43)	1.79 – 3.00
Non-IWB	2.25 (0.53)	1.29 – 3.00	2.37 (0.48)	1.43 – 3.00

Table 6-4 displays the mean levels of task engagement behaviours per individual element and the lesson scores are displayed in Figure 6-3. Kris found the IWB to be slightly more engaging than the non-IWB lessons across both elements, although engagement levels were reasonably high in both conditions. As in total task engagement, there was a slight negative trend across time in both elements of task engagement.

Activity related behaviour **Eye contact**

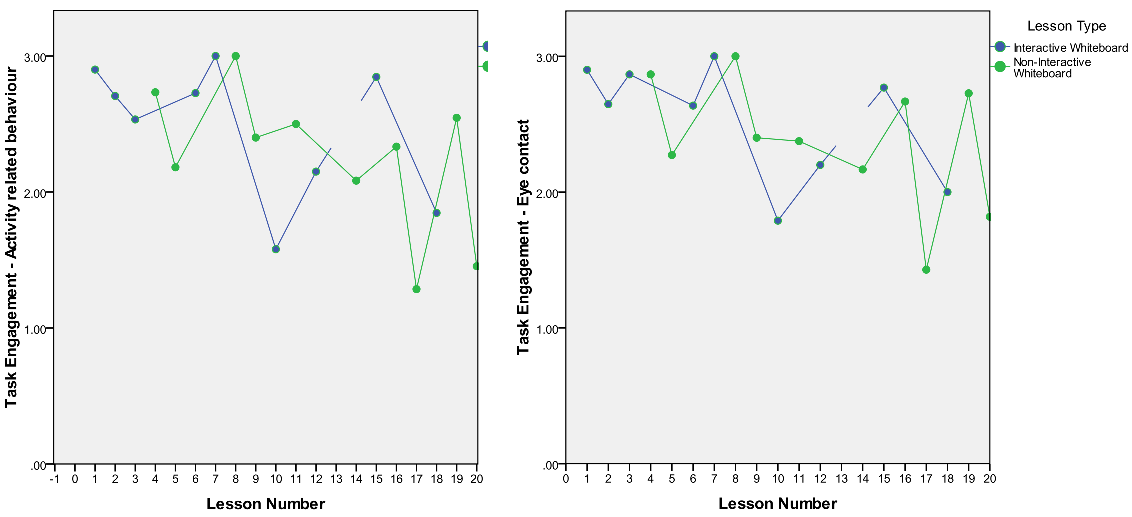


Figure 6-3
Kris: Average activity related behaviour and eye contact: Task engagement elements

The PND analysis score for activity related behaviour was 66% indicating the IWB condition was minimally more effective than the non-IWB condition. The PND result for eye contact was 50%, indicating no difference between the two conditions. The randomisation test results found no statistically significant difference between the two conditions in either element, with a RSS value of 5.59 for activity related behaviour and 4.59 for eye contact, both at α < .05 level.

Affective Engagement

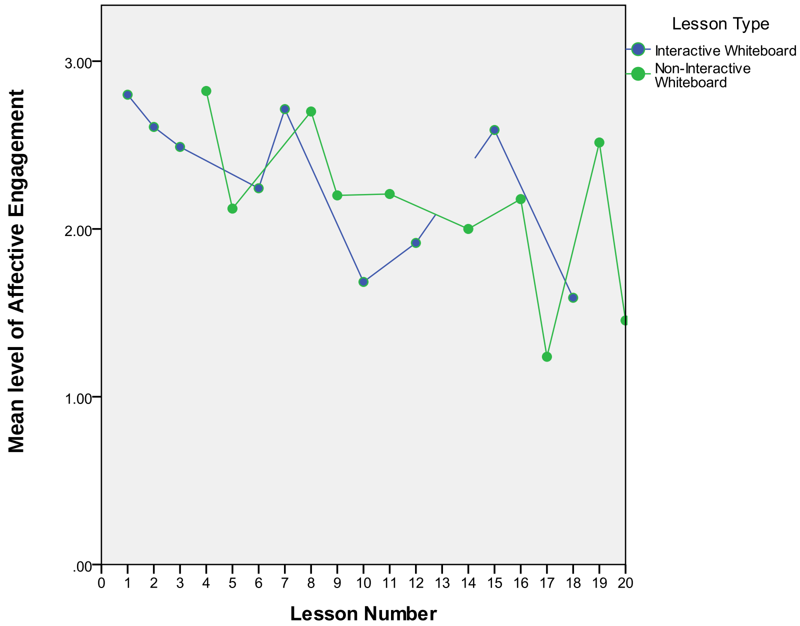


Figure 6-4
Kris: Mean Level of Affective Engagement Behaviours per Lesson
Affective engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

Affective engagement behaviours displayed a negative trend across both conditions, scoring predominantly in the mildly positive to mostly positive range. The scores for the IWB condition were slightly higher with a mean of 2.29, range 1.59 - 2.80 compared with the non-IWB condition's mean of 2.14, range 1.24 - 2.82 (see Table 6-2). The PND analyses indicated Kris displayed no preference across conditions, a result supported by the randomisation test analysis with a RSS value of 4.91 at α < .05 level.

Interactive Whiteboard **Non-Interactive Whiteboard**

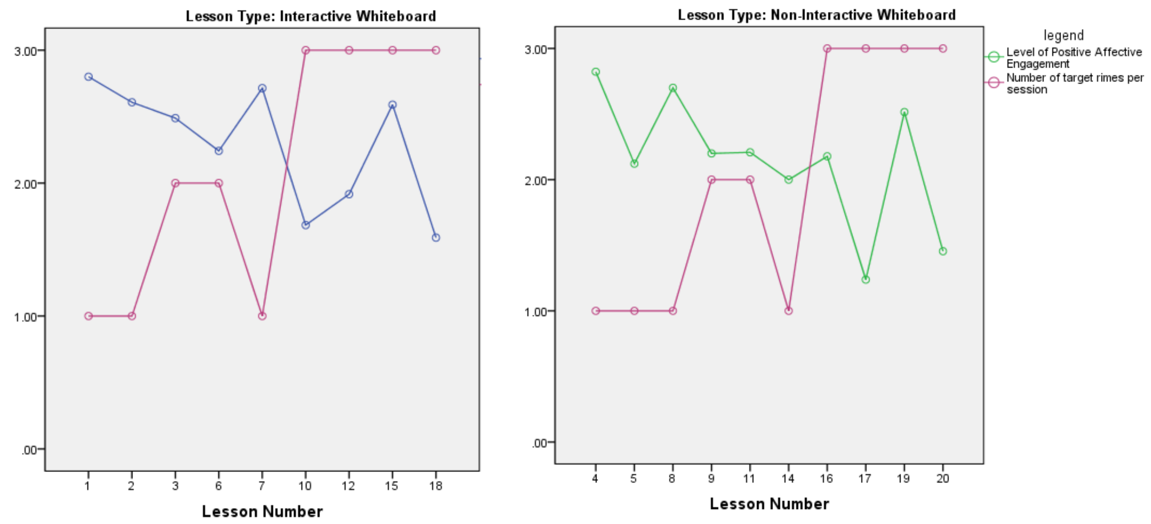


Figure 6-5
Kris: Affective engagement and number of rimes per lesson per IWB and non-IWB conditions

Figure 6-5 depicts the general decline in affective engagement as the number of rimes per lesson increased in both conditions. In the IWB condition, the level of affective engagement was on a steady decline until the focus returned to one rime, where it went up to the level observed in lesson 1. Kris' level of affective engagement was negatively affected when faced with tasks that incorporated sentences, such as cloze or rebus[3] activities.

[3] Sentences in which a word is represented by a picture; i.e. The  sat on the mat.

Individual Elements of Affective Engagement

Table 6-5
Kris: Average Affective Behaviour Engagement scores.

	Affective Engagement Behaviours – Interest		Affective Engagement Behaviours - Mood		Affective Engagement Behaviours - Persistence	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.48 (0.49)	1.74 – 3.00	2.01 (0.33)	1.38 – 2.40	2.39 (0.57)	1.53 – 3.00
Non-IWB	2.29 (0.48)	1.57 – 3.00	2.07 (0.38)	1.43 – 2.73	2.07 (0.72)	0.71 – 3.00

N= 9 IWB; n=10 non-IWB

The engagement scores for the three elements of affective engagement: interest, mood and persistence, are presented in Table 6-5 and depicted in Figure 6-6. The graphs depict a negative trend across time. The overall level of the three elements was in the mildly positive engaged range. Kris' mean scores for interest and persistence were higher in the IWB condition, whereas his mean score for mood was very slightly higher in the non-IWB condition. Variability of scores was higher across the three elements in the non-IWB condition. The PND analyses indicated a minimal effect in favour of the IWB condition. The interest element scored 56% in favour of the IWB, the mood element scored 66% in favour of the IWB lessons, and the persistence element was 66% in favour of the non-IWB lessons. The randomisation test analysis showed values of RSS of 4.99 for interest, 3.13 for mood and 8.27 for persistence, all at $\alpha < .05$ level, results which are not statistically significant for any of the elements.

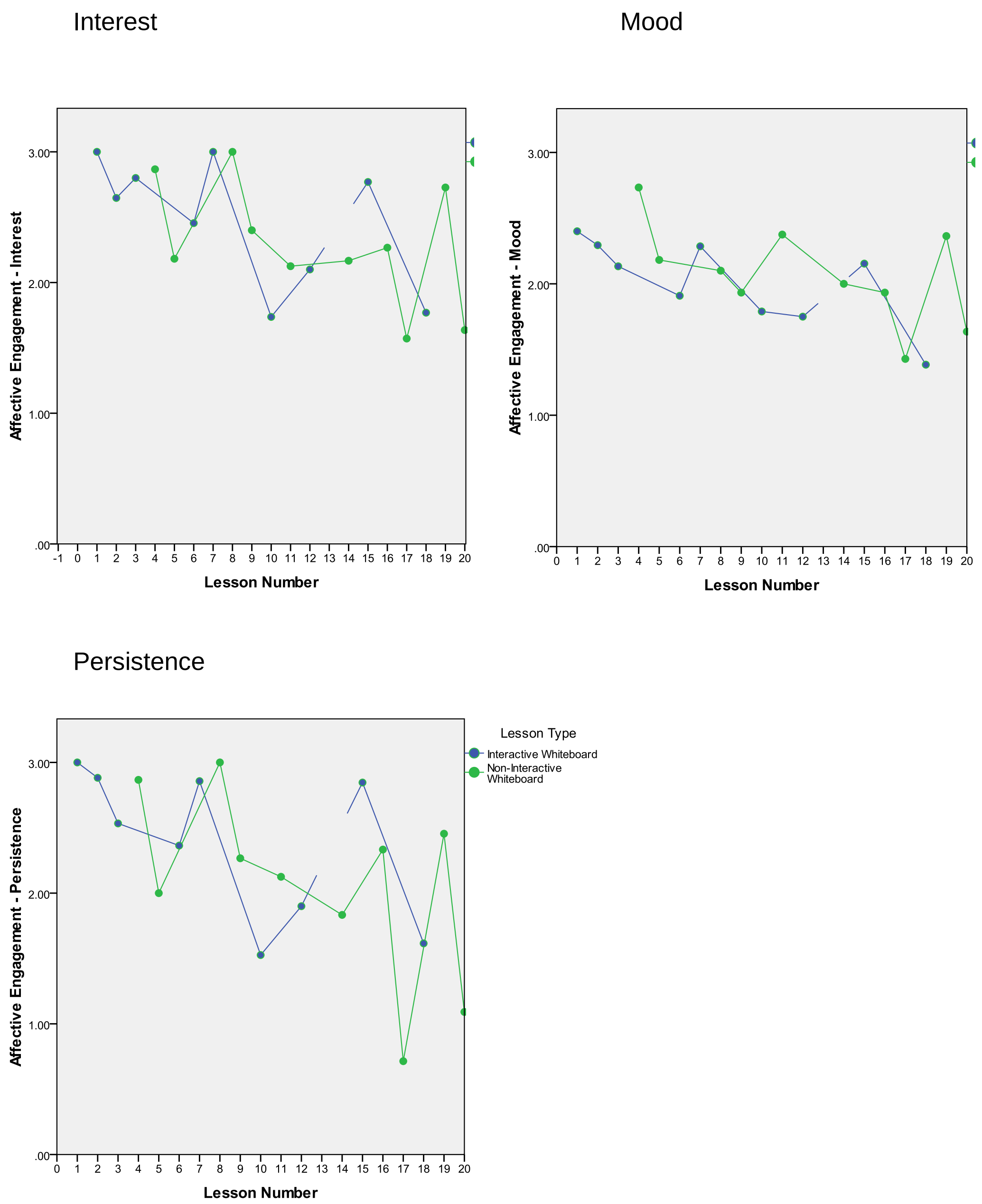


Figure 6-6

Kris: Average Interest, Mood and Persistence per lesson

Interest Scale: 3) shows sustained, intense interest; 2) shows some momentary, intense interest; 1) not upset, but lacks real interest; 0) sad, cries, pouts, angry, frustrated, tantrums. Mood Scale: 3) laughing appropriately, looking to interact with the teacher be part of the group; 2) smiling, looks pleased; 1) bored, expressionless; 0) child not enjoying self. Persistence Scale: 3) independently continued with focus activity, especially when faced with a difficulty/error; 2) attempted to continue on own, but required some assistance to continue with the focus activity; 1) made some effort to complete the focus activity with assistance, no effort when persistence required; 0) no attempt to complete activity when faced with an error/difficulty.

Cognitive engagement

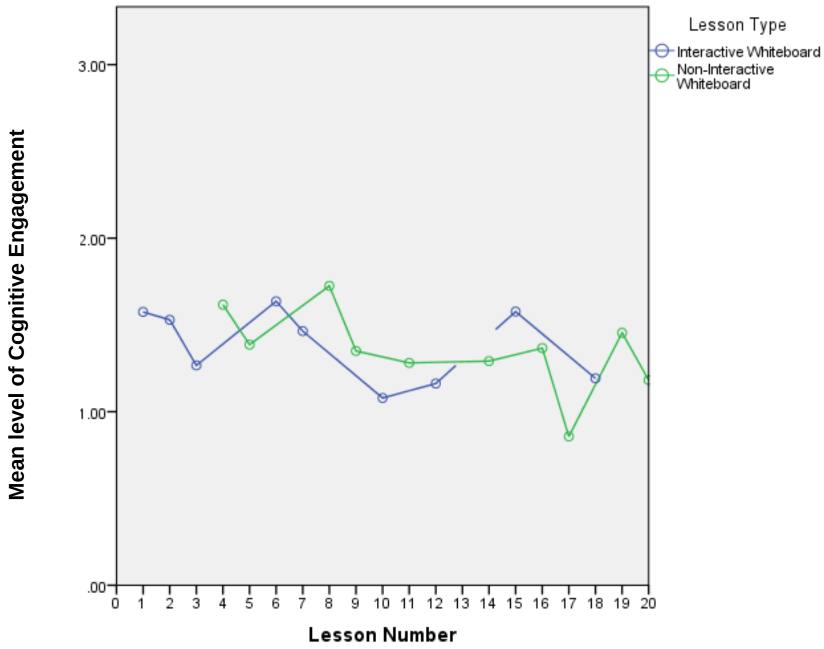


Figure 6-7
Kris: Mean level of cognitive engagement per lesson
Cognitive engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

The mean scores for cognitive engagement presented in Table 6-2 and depicted lesson by lesson in Figure 6-7 indicate very little difference in the levels of cognitive engagement between the two conditions. Both were centred in the mildly negative range, trending slightly downwards across time. The means for both conditions were very similar, the IWB averaging 1.4, range 1.08 – 1.61 and the non-IWB averaging 1.36, range 0.86 – 1.73. The PND calculations did not identify a preference for either condition, a result supported by the randomisation test values, a RSS result of 1.87 at $\alpha < .05$ level.

Interactive Whiteboard Non-Interactive Whiteboard

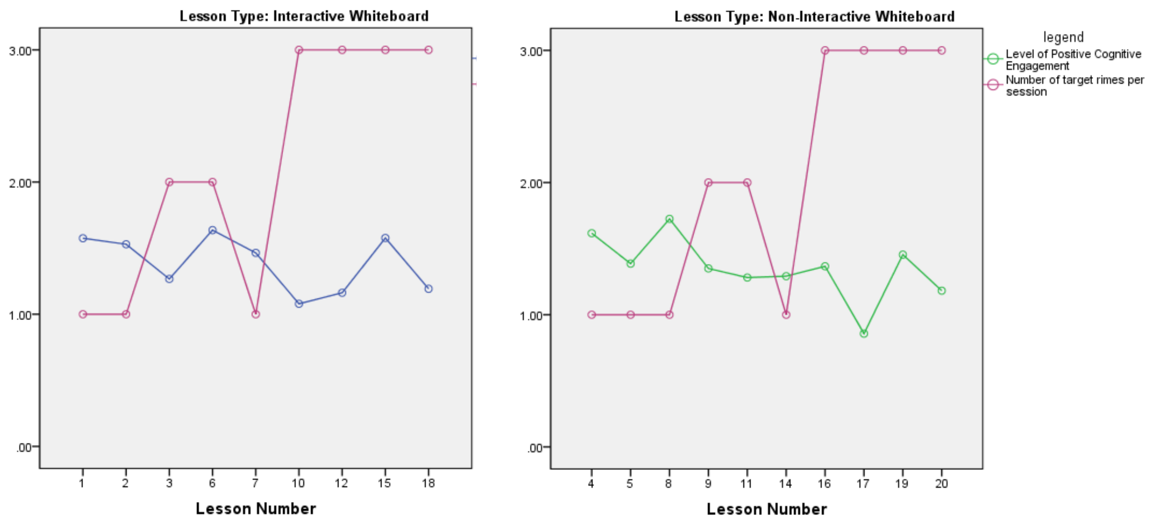


Figure 6-8
Kris: Cognitive engagement and number of rimes per lesson per IWB and non-IWB conditions

Across the lessons in the two conditions, cognitive engagement behaviours tended to be lower as the number of rimes, or cognitive load, increased (Figure 6-8). The cognitive load experienced by Kris was further increased by the contextual presentation of words in sentences and stories, both types of activities that he did not willingly attempt, using statements such as '*too big'* and '*too many words'.*

Individual Elements of Cognitive Engagement

Table 6-6
Kris: Average cognitive engagement behaviours per lesson

	Selection		Elaboration		Monitoring		Problem Solving	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.67 (0.29)	2.26 – 3.00	0.11 (0.10)	0.00 – 0.29	0.30 (0.27)	0.00 – 0.81	2.45 (0.42)	1.92 – 3.00
Non-IWB	2.54 (0.37)	1.86 – 3.00	0.24 (0.25)	0.00 – 0.60	0.28 (0.31)	0.00 – 0.82	2.29 (0.42)	1.57 – 3.00

Across the four elements that constitute the cognitive engagement construct, the mean scores for selection and problem solving were in the mildly to mostly positive behaviours, whilst those for elaboration and monitoring were very low. The same pattern of slight difference in mean scores was present for each element, with only the score for elaboration favouring the non-IWB condition.

Selection

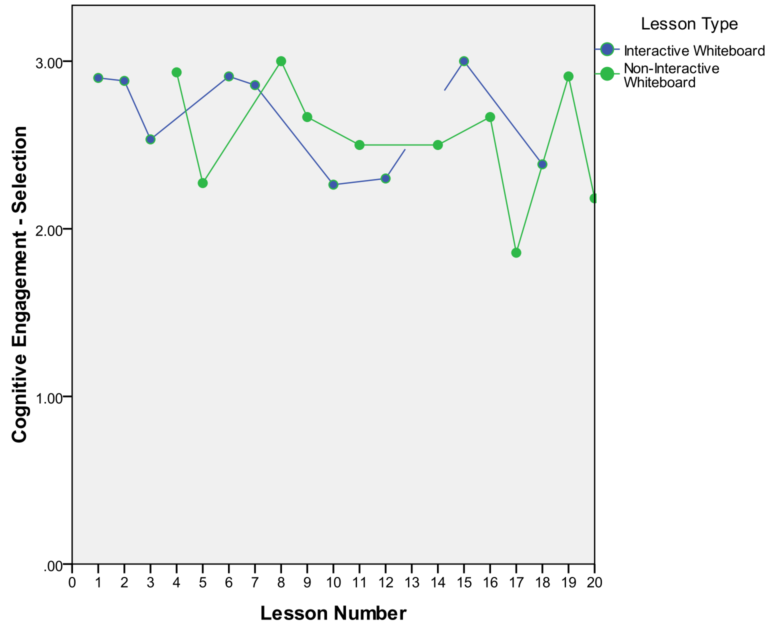


Figure 6-9
Kris: Average appropriate selection attempts per lesson
Selection Scale: 3) independently selects correct material to complete the task; 2) selects some or part of the material, but not enough to complete the task; 1) selects material, but inappropriate to the task; 0) no sign of selecting the material.

Kris consistently displayed the ability to correctly and independently select the relevant materials to complete the tasks set, recording a high level of engagement in this element across most lessons in both conditions. There was no discernible difference between the IWB (mean 2.67, range 2.26 – 3.00) and the non-IWB (mean 2.54, range 1.86 – 3.00; as shown in Table 6-6), and the many overlapping data points depicted in Figure 6-9 made it difficult to determine a preferred condition without performing PND calculations. The PND results indicated a minimal preference of 56% towards the IWB, and a RSS value of 2.91 at α < .05 level, not statistically significant, supported the lack of difference in engagement scores between the two conditions.

Elaboration

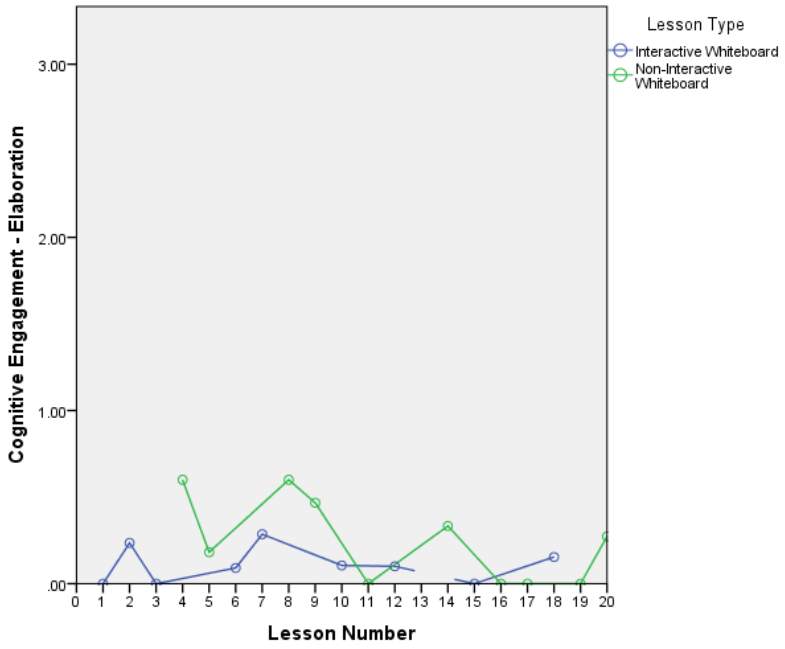


Figure 6-10
Kris: Average elaborated responses per IWB and non-IWB lessons
Elaboration Scale: 3) independently connects material with an original elaboration, extends ideas, creates other relevant word. Can include non-verbal responses; 2) with or without prompting, connects material with previous learning; 1) with or without prompting, attempts to elaborate, but no clear connection with the material; 0) no sign of connecting material to prior learning.

In contrast to the selection activity, Kris' elaboration activity was at a very low level. He rarely made an explicit attempt to connect the newly presented material to prior knowledge or to expand upon the concept presented to him. The IWB condition averaged 0.11 elaborations per lesson (range 0.00 – 0.24) and the non-IWB averaged 0.24 elaborations per lesson, with an average range of responses of 0.00 – 0.60 (see Figure 6-10). The PND indicated a minimal preference towards the non-IWB condition at 56%. The randomisation test analysis indicated no preference towards either condition with a RSS value of 1.64 at $\alpha < .05$ level.

Upon further investigation, the occurrence of verbal elaborations varied between the conditions, and this will be discussed in the following section.

Verbal elaborations

The following information discusses the number of utterances, whether elaborative or irrelevant, made by Kris during individual lessons. The data may appear different to that depicted in Figure 6-10 as that data reflects both non-verbal and verbal elaborations.

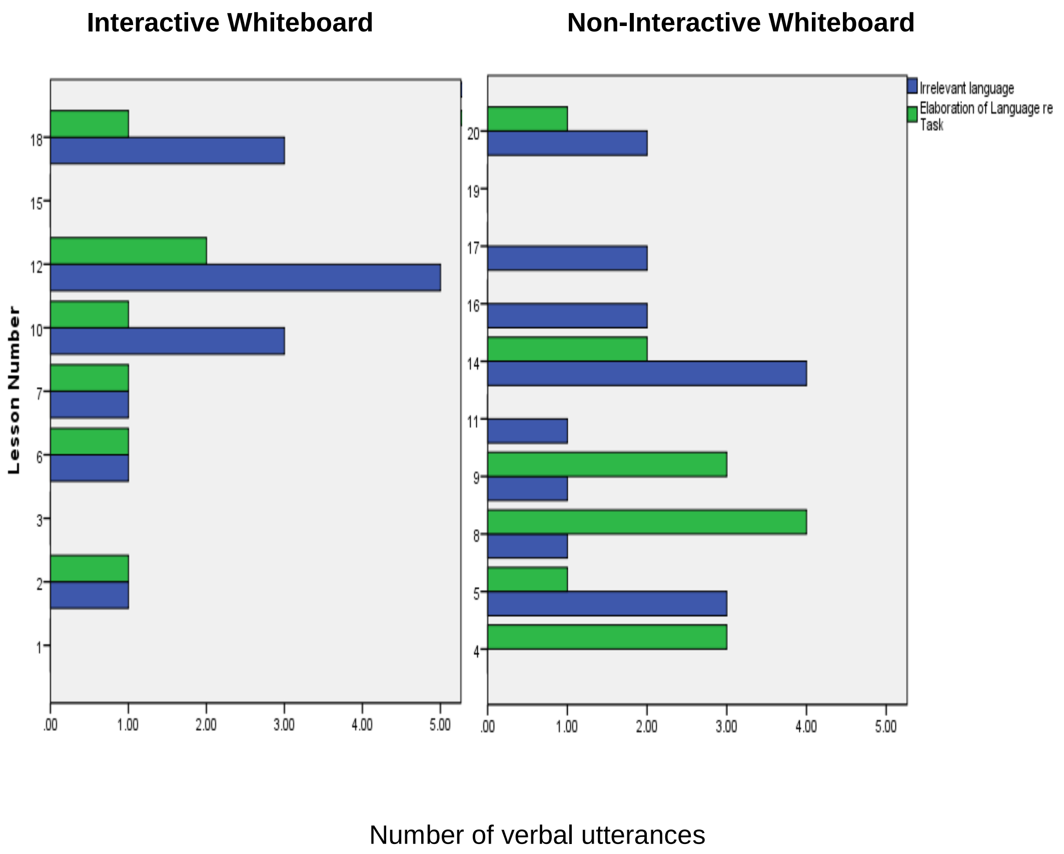


Figure 6-11
Kris: Occurrence of relevant elaborated language and irrelevant responses per condition and lesson
IWB frequency = 7 relevant, 14 irrelevant; non-IWB frequency = 13 relevant, 16 irrelevant

Kris was a very chatty student. He was able to ask questions, answer questions, and converse with the researcher. By the thirteenth lesson he had learnt that 'because' was not acceptable as an answer! For example, the following conversation occurred during Lesson 13, the eighth IWB lesson, in which he was asked to read '*Kris' "at" book*':

K: *No, no. I don't want to read this*.

R: *Why?*

K: *Because.*

R: *Why*?

K: *Because, (pause) because isn't an answer is it*?

R: *No. Because wh*y?

K: *Because there are a lot of words.*

As lessons become more difficult, and the cognitive load of a task increased, his language would stay on task, but lessen in quantity, with him only commenting or contributing directly to the task. Figure 6-11 depicts how the number of verbal elaborations occurred over time, and in four of the lessons, no elaborations or irrelevant language responses were recorded.

Relevant, elaborated responses in the IWB condition were responses such as '*That my name!*' indicating he recognised his name; '*if you had a sagging bed you'd have to buy a new one'* indicating an understanding of the word presented; or connected the word /bug/ to '*An insect'.* The frequency of the relevant, elaborated responses was half that observed in the non-IWB condition. The frequency of irrelevant responses was comparable to those in the non-IWB condition. Many of the irrelevant comments made were in connection to the stylus used to operate the IWB; '*I want it to be fat', 'I want green', 'Why, why not the wand? Why?'*; or not wanting to do a task; *'I don't want to do that', 'Is it the last page?'.*

Relevant responses offered in the non-IWB condition were again grouped into utterances that showed his understanding of a word. For example, Kris conducted a conversation about his knowledge of a word such as '*I fell /in/ the pool without my bathers on. Ha, Ha', 'It has a /f/ in it', 'What we love and kiss with. I don't kiss with my /lips/!*' His irrelevant responses were very similar to those in the IWB condition; expressing his desire not to do a task or to change what was being asked of him. For example '*I'm gonna write now', 'I don't want to say them'*.

Monitoring

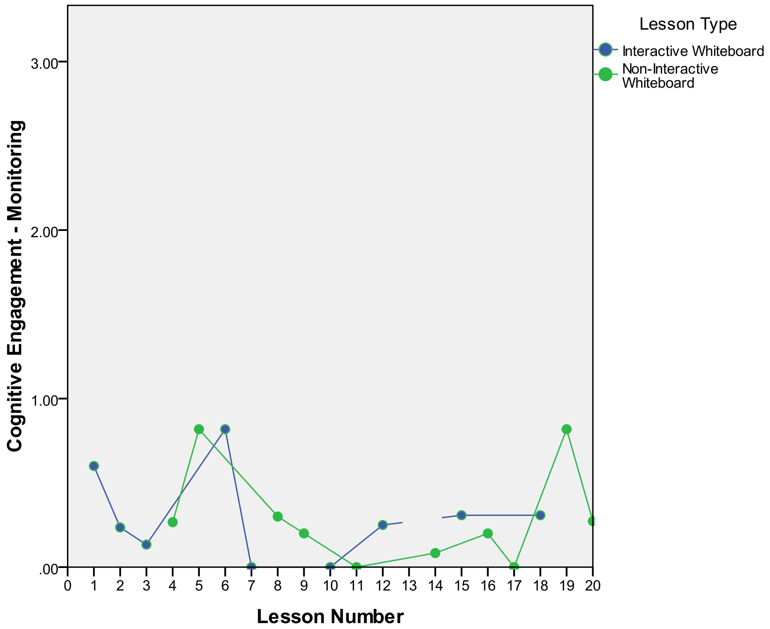


Figure 6-12
Kris: Average monitoring attempts per lesson.
Monitoring: 3) with no prompting, self-corrects, asks relevant questions; 2) with prompting recognises error, some comments related to error and/or task. No relevant questioning; 1) with prompting, shows some recognition of error, but no clear connection or questions related to task; 0) no sign of self-correction, questioning, recognition of error.

Self-monitoring levels across both conditions, as depicted in Figure 6-12 and presented in Table 6-6, were very low, indicating that Kris rarely checked his answers for accuracy. The mean in the IWB condition was 0.30 (range 0.00 – 0.81) and the non-IWB mean was 0.28 (range 0.00 – 0.82). The PND analysis and RSS value also support the observation that no preference existed between the two conditions at 50% and 2.37 at α < .05 level respectively.

Problem Solving

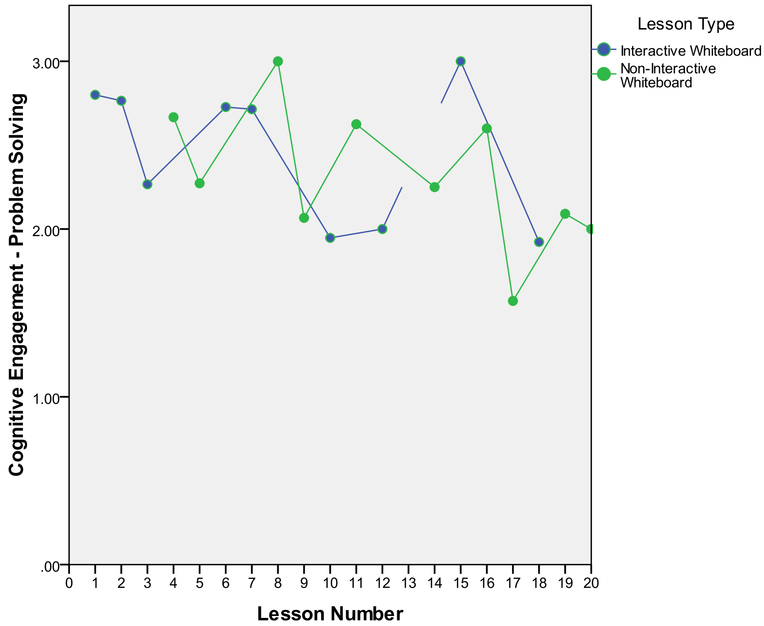


Figure 6-13
Kris: Average attempts at problem solving per lesson.
Problem Solving: 3) carries out task spontaneously and accurately; 2) attempts on own, partially correct; 1) some progress with much assistance; 0) no progress or not required.

Kris' attempts at problem solving across the lessons were in the mid to high range, with a negative trend. In both conditions Kris displayed an ability to independently and spontaneously attend to the task of problem solving, attaining one score of 3.00 in each condition (L8 and L15). These mean scores indicate Kris would attempt to independently solve problems before him, often being successful without prompting from the researcher. However, as the tasks became more difficult, he would generally require some assistance to successfully complete the tasks. This trend can be seen in Figure 6-13. The means for the two conditions show a preference towards the IWB condition, and a slightly higher starting score regarding the range of scores recorded (2.45, range 1.92 – 3.00) against the non-IWB mean and range (2.29, range 1.57 – 3.00; see Table 6-6). However, there are many overlapping data points, making a visual inspection of the data difficult. The PND indicate a minimal preference towards the IWB condition at 56%. The randomisation test analysis also showed no distinction between the two conditions in the problem solving element with a RSS value of 3.97 at $\alpha < .05$ level.

The problem solving skills used by Kris were consistent across the conditions. He would look at the researcher's or the Reading Doctor™ mouth when the words or letters were being formed, listen closely, attempt to sound out, ask questions, use the picture clues and the beginning letter of the word to 'predict' the answer. For example, Kris would look at the picture of a girl sitting on a chair as in 'Sam (pseudonym) /sat/ on a chair', recognise the word /chair/ began with a /c/ and answer '*couch'.* He would look at the initial letter or hear the sound and would then recall words he knew to 'read'. For example, when presented with the word /fin/ in lesson 5, he replied '*fox'*; on prompting to sound out the letters, he responded with '*fin'*. When using the Reading Doctor™ program on the IWB, Kris would also press on the letters to re-hear the letter or word being targeted.

When Kris used the sounding and blending skill, he was generally successful in decoding the target words, but would need reminders to use this strategy.

Cognitive Load

Table 6-7
Kris: Number of rimes per lesson, number of target words per lesson and the introduction of new rimes

Lesson No.	1	2	3	4	5	6	7	8	9	10
	NR		NR		NR					
IWB Sequence	L1	L2	L3	L6	L7	L10	L12	L13	L15	L18
No. rimes	1	1	2	2	1	3	3	3	3	3
No. words	4	7	8	8	5	11	11	11	8	16
	NR			NR		NR				
Non-IWB Sequence	L4	L5	L8	L9	L11	L14	L16	L17	L19	L20
No. rimes	1	1	1	2	2	1	3	3	3	3
No. words	3	3	4	8	8	3	11	15	15	11

NR = new rime introduced

Table 6-7 shows the order in which the lessons were taught and also the lessons when new rimes (NR) were introduced to Kris. Kris had an additional lesson in the IWB condition with all the rimes, as the second rime was introduced a lesson earlier in this condition.

Kris was formally introduced to three rime families across the two conditions. In lesson 20 of the IWB sessions, Kris, whilst clicking on the whiteboard, brought up a Reading Doctor™ game with an unknown, random selection of cvc words which he attempted to complete for five recording intervals before shutting down the program. In the non-IWB condition, during the game of Snakes and Ladders (L17 and L19), three non-target rimes were successfully read when landed upon. In both instances the random words were presented in a 'word only' format, not requiring Kris to decode sentences. These attempts indicated Kris could independently transfer the skill of sounding and blending to non-target words. However, upon feeling overwhelmed, he would then resort to 'walking away' from the challenge.

Kris generally attempted unknown rimes/words when they were presented individually, but would complain of too many words when presented with cloze activities or stories. He was also familiar with the /at/ rime, announcing the words presented were '*too easy'.* Therefore, to test his /at/ knowledge, other /at/ words were presented in lesson 2 before moving on to the next rime. When tasks were familiar, such as those involving the game of memory, cloze and matching, Kris was more likely to express his understanding of the target words, often elaborating upon the sentence or word presented. For example, whilst cutting up /ip/ words during lesson 9, he elaborated upon how good a swimmer he had become (/dip/ in a pool). This conversation lasted 1.40 minutes, before the focus of /dip/ changed to food.

Correlations were calculated between scores for the three engagement constructs and the number of rimes.

Table 6-8
Kris: Pearson's correlation comparing the relationships between the number of target rimes presented and task, affective and cognitive engagement scores

	Task Engagement	Affective Engagement	Cognitive Engagement
IWB N = 9	-.725*	-.777**	-.657*
Non-IWB N = 10	-.473	-.534	-.576*

**Correlation is significant at the 0.05 level (1 tailed)

* Correlation is significant at the 0.01 level (1 tailed)

The correlations presented in Table 6-8 suggest there was a moderate to strong, negative correlation between the number of rimes presented and task, affective and cognitive engagement in the IWB condition, the correlations being statistically significant for the three engagement constructs. The correlations were at a slightly lower level for the non-IWB. Statistical significance was attained in the cognitive engagement construct in the non-IWB condition. The negative correlations in both conditions indicated as the number of rimes increased, a corresponding fall in engagement scores was observed.

Rime Acquisition

As mentioned above, Kris was introduced to three rime families across both conditions. Both the second and third rime taught in the IWB condition were introduced a lesson earlier than the corresponding rimes in the non-IWB condition. This was due to Kris declaring the /at/ rime was too easy, so after a check out to confirm he knew how to decode a selection of /at/ words, the new rime was then introduced. Once all three rimes were introduced, Kris required additional time with the three rimes to practice the sounding and blending strategy to distinguish the difference between similar looking words. For example, initially he had some difficulty identifying the difference between /bag/, /bug/ and /bat/.

Summary: Kris

Again, the rule used to determine whether a difference between the two conditions was evident was where all three analyses were in the same direction in favour of one condition, a consistent difference was assumed; a favourable difference existed when two of three analyses were in the same direction; and no difference existed when one or none of the results were in favour of a condition.

Table 6-9
Kris: Summary of engagement behaviours

Type of Engagement Behaviours	Individual Engagement Elements	Visual Analysis	PND Effect	Randomisation Test	Summary
Task engagement		no visual difference	minimal IWB > non-IWB	no significance	no difference
	Activity related	no visual difference	minimal non-IWB > IWB	no significance	no difference
	Eye contact	no visual difference	no relationship	no significance	no difference
Affective engagement		no visual difference	no relationship	no significance	no difference
	Interest	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Mood	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Persistence	no visual difference	minimal non-IWB > IWB	no significance	no difference
Cognitive engagement		no visual difference	no relationship	no significance	no difference
	Selection	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Elaboration	no visual difference	minimal non-IWB > IWB	no significance	no difference
	Monitoring	no visual difference	no relationship	no significance	no difference
	Problem solving	no visual difference	minimal IWB > non-IWB	no significance	no difference

Kris developed the skill of sounding and blending across the 20 lessons, and successfully read 50% of the presented cvc words on the post-test. However, in lessons seventeen and twenty he successfully read/sounded/blended unknown words when encountered in Snakes and Ladders and the Reading Doctor™, indicating that he could transfer his developing skill to unfamiliar words. Both Kris' verbal expressions of interest and the mean engagement scores indicated a slightly higher engagement when working on the IWB, However, the PND analysis and randomisation testing did not indicate that there were differences between the conditions on any of the engagement measures (see Table 6-9).

Language production was shown to be more pronounced in the non-IWB condition, with nearly twice as many relevant utterances recorded across the ten lessons. This is an important observation as Kris has a severe language delay as well as an intellectual disability, and oral language development is an important underpinning towards becoming a successful reader. Kris would use gestures and rephrase comments if not immediately understood, displaying a high level of persistence in trying to convey meaning and understanding of the tasks set before him.

The introduction of the second new rime occurred a lesson earlier in the IWB condition, lesson three against the fourth lesson in the non-IWB condition, which on the surface could indicate this mode of delivery was a preferred way of learning. However, Kris did indicate that the /at/ lessons were '*easy, peasey'* because he was familiar with the /at/ rime. The introduction of the third rime occurred after the same number of lessons had passed. This indicated that Kris was able to acquire the skill of sounding and blending, regardless of the condition in which the lesson was presented.

7. CORRINE

Corrine was 8.4 years of age when she participated in the research. She was in Year Three at school, and had spent her first year (four terms) of schooling in a mainstream class before moving to a special class setting where she had been for two years and 1 term (9 terms). She had been identified with Global Developmental Delay and Speech and Language Disorder prior to commencing school and, until the current year, her behaviour had been classified as 'extreme', meaning her classroom behaviour was highly volatile. Corrine would destroy other student's work, throw furniture, physically strike students, teachers and support workers, scream, lie on the floor and refuse to move. During the time of the data gathering Corrine did not display these extreme behaviours, but had developed some avoidance strategies, so that once she had decided not to work, it was very difficult to coax her back to the lesson. Her oral language was clear and easy to understand, but she had receptive language difficulties which meant she had trouble understanding and following information, instructions and explanations. At the time of the research she was working with a speech pathologist on developing these skills.

Lesson History

Being quite sociable, Corrine generally came willingly to lessons although she did not necessarily engage with the lessons once there. The results that follow will clearly identify those lessons in which she was not engaged. Usually there was no obvious reason for her being off task, with the exception of lesson 17. Prior to this lesson, she had spent the morning with a psychologist and was tired. During lesson 17 Corrine displayed some evidence of her difficult behaviour, not complying with any requests to participate in the lesson by rolling around on the floor, laughing and playing with the features of the IWB. As indicated below data from this lesson were not included in the final analyses for Corinne.

All lessons were completed in a variety of settings within the school's open space unit depending on the availability of IWBs and free work space. The unit was generally a noisy place with five classes contained within an open area; the noise was exacerbated by major building works occurring immediately outside the unit. Corrine's class was one of the five located within the unit, so she was familiar with the setting and the noise.

Video data was unable to be coded in lesson 2 due to the file not down-loading successfully, and in lesson 15 when Corrine placed her jumper over the camera lens, resulting in nine lessons available for analysis in each condition.

Pre-test and post-test reading task results

Table 7-1
Corrine's Pre and Post test results

Word presented	Pre-test	Percentage correct	Post test	Percentage correct
vc		**0%**		**75%**
an	apple		at	x
on	Don't know		on	✓
it	Thomas		it	✓
is	stop		is	✓
cvc		**0%**		**60%**
ran			nit	X
bed			**dip**	X
mop			mop	✓
bin			bit/**dip**/bin	✓
leg			**led**/leg	✓
pat			pat	✓
dog			dog	✓
sad			stop	X
pig			pig	✓
fan			fun/**fin**	X

The results of Corrine's pre and post-tests are presented in Table 7-1. She was able to identify the sixteen individual letters both aurally and visually, and therefore was moved on to the vc and cvc component of the pre-test.

Prior to the lessons, Corrine would guess words based on familiar sounds or letters in the words presented. For example, when she was presented /an/ without hesitation, she 'read' /apple/, recognising the initial letter as /a/. When presented with the words /it/ and /is/ the predominant sounds or letters she recognised were /t/ and /s/, and produced /Thomas/ and /stop/, words beginning with those sounds. No cvc words were presented pre-test due to no correct responses given in the vc condition.

On presentation of the words on the post-test, Corrine continued to 'read' the words according to the dominant sound or letter within the word, but on prompting to sound and blend, she successfully read 75% of the vc words and 60% of the cvc words presented. She failed to correctly read the words /bed/ and /fan/, responding with words she had learnt during the lessons. There were two other responses with taught words, but she corrected her answer on prompting to sound and blend the letters in front of her (responses are highlighted in bold in Table 7-1). The word /mop/ was in her current take-home reader, which she retrieved to show the researcher, matching the word /mop/ in her reader to the test.

Anecdotally, her special class teacher indicated approximately two terms later:

> *"…Corinne had 'got' blending (skill level still varies somewhat) – has learnt many letter combinations and is oh so enthusiastic about her reading. She is blending /t/r/ee (she learned ee through explicit phonics IWB work) and was so excited about the discovery that her behaviour was off for the next two weeks!"*

Engagement

Engagement behaviours in lesson 2, an IWB lesson, were unable to be coded, due to the video file being corrupted and also in lesson 15, a non-IWB lesson, due to Corrine placing her jumper over the camera lens.

The descriptive data tables show information for all lessons able to be coded, and a second IWB line, identified with # and the use of italics, are with the outlier lesson, lesson 17, included. It became evident that the inclusion of lesson 17 distorted the results of the engagement behaviours in the IWB condition, and data from this lesson has not been included after this initial introduction.

Table 7-2
Corrine: Means and Ranges for Engagement Behaviours

	Task Engagement Behaviours		Affective Engagement Behaviours		Cognitive Engagement Behaviours	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.56 (0.29)	2.00 – 2.87	2.20 (0.14)	2.02 –2.47	1.23 (0.11)	1.07 –1.43
#	*2.40 (0.56)*	*1.09 – 2.87*	*2.08 (0.36)*	*1.18 –2.47*	*1.16 (0.22)*	*0.64 –1.43*
Non-IWB	2.56 (0.25)	2.13 – 2.92	2.28 (0.24)	1.83 –2.51	1.22 (0.14)	1.00 –1.41

#including lesson 17

The means for the engagement behaviours across the three engagement constructs are very similar in value in both conditions (Table 7-2) when lesson 17 is excluded from the data. Corrine's average engagement behaviours were in the positive behaviour range in both the IWB and non-IWB conditions for task and affective engagement, and in the mildly negative range for cognitive engagement. When the data for lesson 17 is included, as identified by #, the non-IWB becomes the more engaging condition due to the wider range of scores identified in the IWB condition, lowering the mean scores for the IWB.

Table 7-3
Corrine: Pearson's correlations between the three engagement constructs of task, affect and cognition across the IWB and non-IWB conditions^

Lesson Type		Level of Affective Engagement	Level of Cognitive Engagement
IWB	Level of Task Engagement ^	.651*	.336
^N=8	Level of Affective Engagement ^		.671*
Non-IWB N=9	Level of Task Engagement	.840**	.532
	Level of Affective Engagement		.853**

**Correlation is significant at the 0.01 level (1 tailed).
*Correlation is significant at the 0.05 level (1 tailed).
^Outlier Lesson 17 removed

The correlations shown in Table 7-3 indicate there were mostly strong positive correlations among task, affective and cognitive engagement scores, the exceptions being that between task and cognitive engagement in both conditions. This suggested that when Corrine was positively engaged in a task she was not overtly cognitively engaged, however when she was positively affectively engaged, she was also positively task engaged and cognitively engaged.

Task Engagement

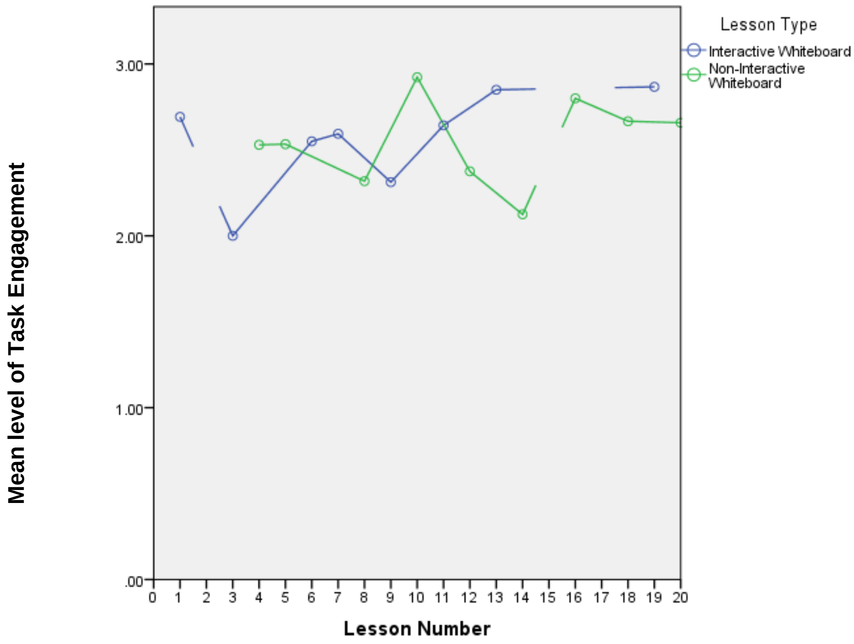


Figure 7-1
Corrine: Mean level of task engagement behaviours per lesson^
Task engagement scores: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours
^Outlier Lesson 17 removed

Figure 7-1 depicts Corrine's mean task engagement scores across the 17 lessons for the two conditions. Generally, Corrine was moderately engaged, scoring in both conditions within the mildly to mostly positive behaviour range. The range of scores was slightly broader in the IWB condition (see Table 7-2).

Due to the high variability across the lessons, it was difficult to determine a pattern of difference in the levels of task engagement between the two conditions. The PND analysis indicated a moderate preference towards the IWB condition at 71.4%. The randomisation test analysis did not identify a statically significant difference between the conditions, with a RSS value of 1.07 at α < .05.

Interactive whiteboard　　　　　　Non-interactive whiteboard

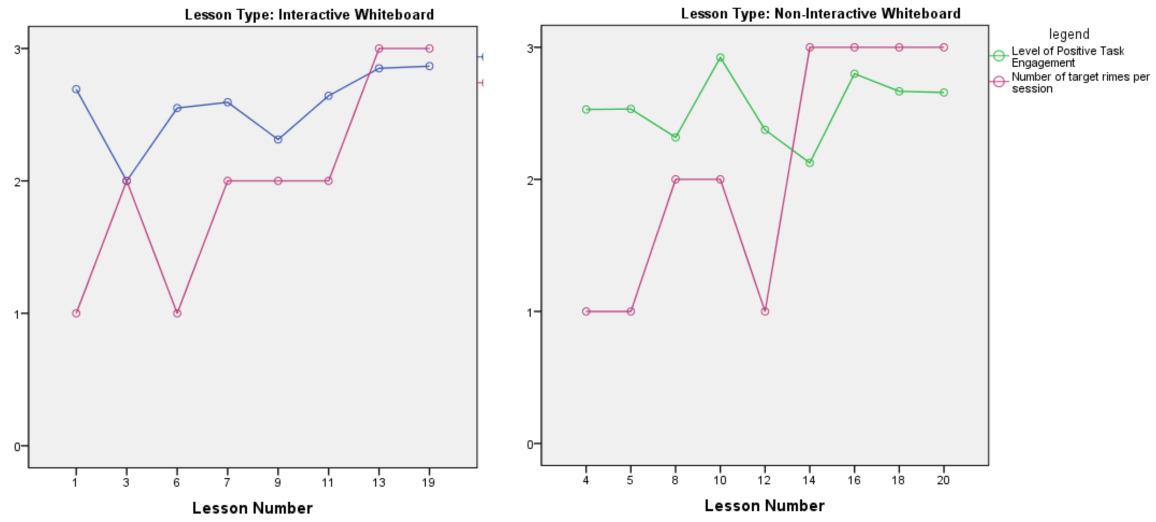


Figure 7-2
Corrine: Task engagement and number of rimes per lesson per IWB and non-IWB conditions^
^Outlier Lesson 17 removed

Figure 7-2 displays the level of task engagement against the number of rimes taught per lesson. Corrine's task engagement on the IWB appears to have a slight upward trend, whereas the overall trend in the non-IWB lessons is flat. The introduction of a new rime in the IWB condition saw a fall in task engagement on the first occasion, but no change on the second, and in the non-IWB condition, a drop in task engagement occurred in both instances of the new rime being introduced.

Individual Elements of Task Engagement

Table 7-4
Corrine: Average Task Engagement Behaviours per lesson^

	Task Engagement Behaviours – activity related behaviour		Task Engagement Behaviours – eye contact	
	M (SD)	Range	M (SD)	Range
IWB^	2.58 (0.33)	1.94 – 2.90	2.55 (0.25))	2.06 – 2.87
Non-IWB	2.56 (0.24)	2.13 – 2.92	2.54 (0.26)	2.13 – 2.92

N = 9
^Outlier Lesson 17 removed

Table 7-4 presents the overall mean levels of the individual elements of task engagement. For both elements, the level of engagement was in the highly positive range, indicating that Corrine was frequently engaged, and attended to the activity and maintained eye contact with the task or researcher. The mean for the IWB condition was 2.58 (range 1.94 – 2.90) for task related activity and 2.55 (range 2.06 – 2.87) for eye contact. In the non-IWB condition the means were 2.56 (range 2.13 – 2.92) and 2.54 (range 2.13 – 2.92) for activity related behaviours and eye contact respectively.

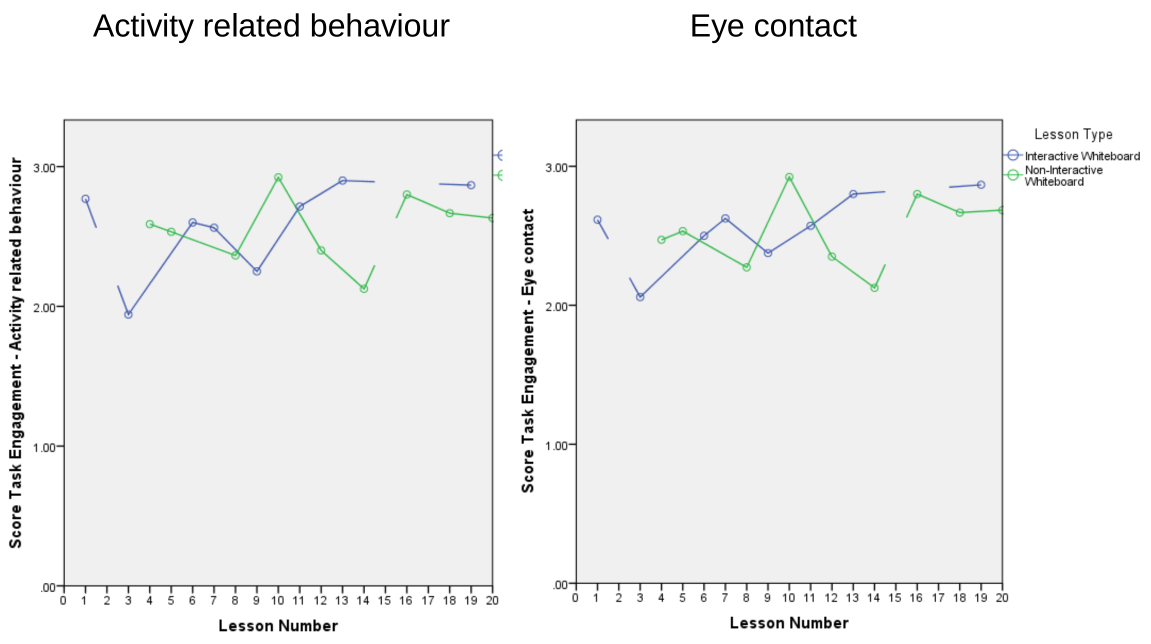


Figure 7-3
Corrine: Average activity related behaviour and eye contact: Task engagement elements^
^Outlier Lesson 17 removed

Figure 7-3 represents the mean levels of task engagement behaviour per element and per lesson, and shows the variability across lessons with the overlapping data points. On calculation of PND, the IWB lessons were moderately more engaging at 71.4% in the activity related element than the non-IWB lessons, and minimally more engaging in the eye contact element at 57%. The randomisation tests indicate no preference between the two conditions in either activity related behaviour or eye contact with RSS values of 1.22 and 0.98 respectively, both at $\alpha < .05$.

Affective Engagement

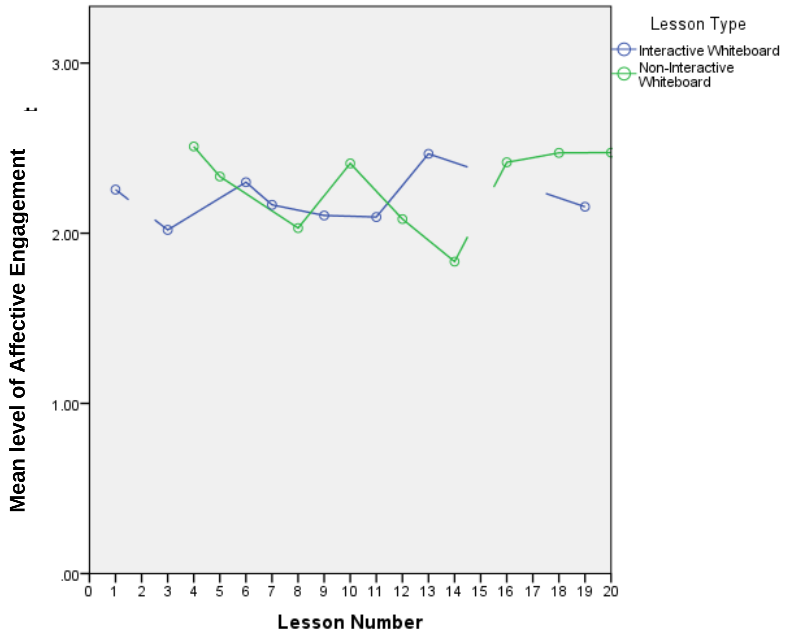


Figure 7-4

Corrine: Mean Level of Affective Engagement Behaviours per Lesson^

Affective engagement scores: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

^Outlier Lesson 17 removed

Corrine's overall affective engagement, as depicted in Figure 7-4, was mildly positive across both conditions, indicating that she was generally pleased to come to lessons and participate. She would show periods of intense interest and would make some effort on her own, but required assistance to perform an activity when persistence was required.

On inspection of the PND, Corrine was similarly affectively engaged in both conditions with there being no preference for either condition. The randomisation test analysis resulted in a RSS score of 0.61, which was not statistically significant at the 5% level.

Interactive Whiteboard Non-Interactive Whiteboard

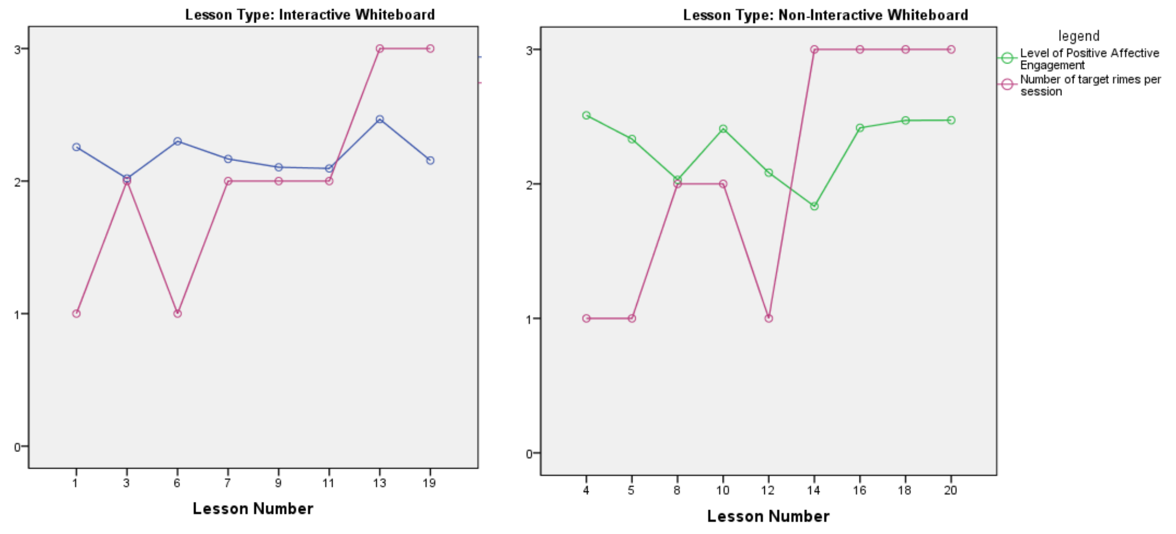


Figure 7-5
Corrine: Affective engagement and number of rimes per lesson per IWB and non-IWB conditions^
^Outlier Lesson 17 removed

The introduction of new rimes was not associated with any substantial change in Corrine's affective engagement level in the IWB condition. A more noticeable fall in affective engagement occurred in the non-IWB condition when an additional rime was introduced. However, similar to task engagement, her affective engagement bounced back in the subsequent lessons. These scores are represented in Figure 7-5.

Individual Elements of Affective Engagement

Table 7-5
Corrine: Means, Standard Deviations and Ranges for Affective Behaviour Engagement scores^

	Affective Engagement Behaviours – interest		Affective Engagement Behaviours – Mood		Affective Engagement Behaviours – Persistence	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB^	2.35 (0.21)	2.06 – 2.80	2.01 (0.16)	1.81 – 2.30	2.22 (0.27)	1.82 – 2.60
Non-IWB	2.49 (0.26)	2.13 – 2.80	2.17 (0.22)	1.75 – 2.53	2.19 (0.37)	1.63 – 2.67

^Outlier Lesson 17 removed

The mean scores for the individual elements of affective engagement (Table 7-5 and Figure 7-6) indicated that Corrine was more affectively engaged in two of the three elements in the non-IWB condition than the IWB.

Generally, Corrine displayed momentary, intense interest in both the IWB and non-IWB conditions, indicating that she could sustain interest in the tasks being undertaken with some direction from the researcher. The same can be said for Corinne's mood levels across the two conditions. She approached most lessons with a happy disposition, although there was a wider range of scores obtained in this element. Her persistence levels were in the positive range, indicating that she would attempt to complete tasks on her own, but required some prompting to complete the focus activity. Prompting usually took the form of oral prompts such as "*look at the letters*" or "*sound out the word*".

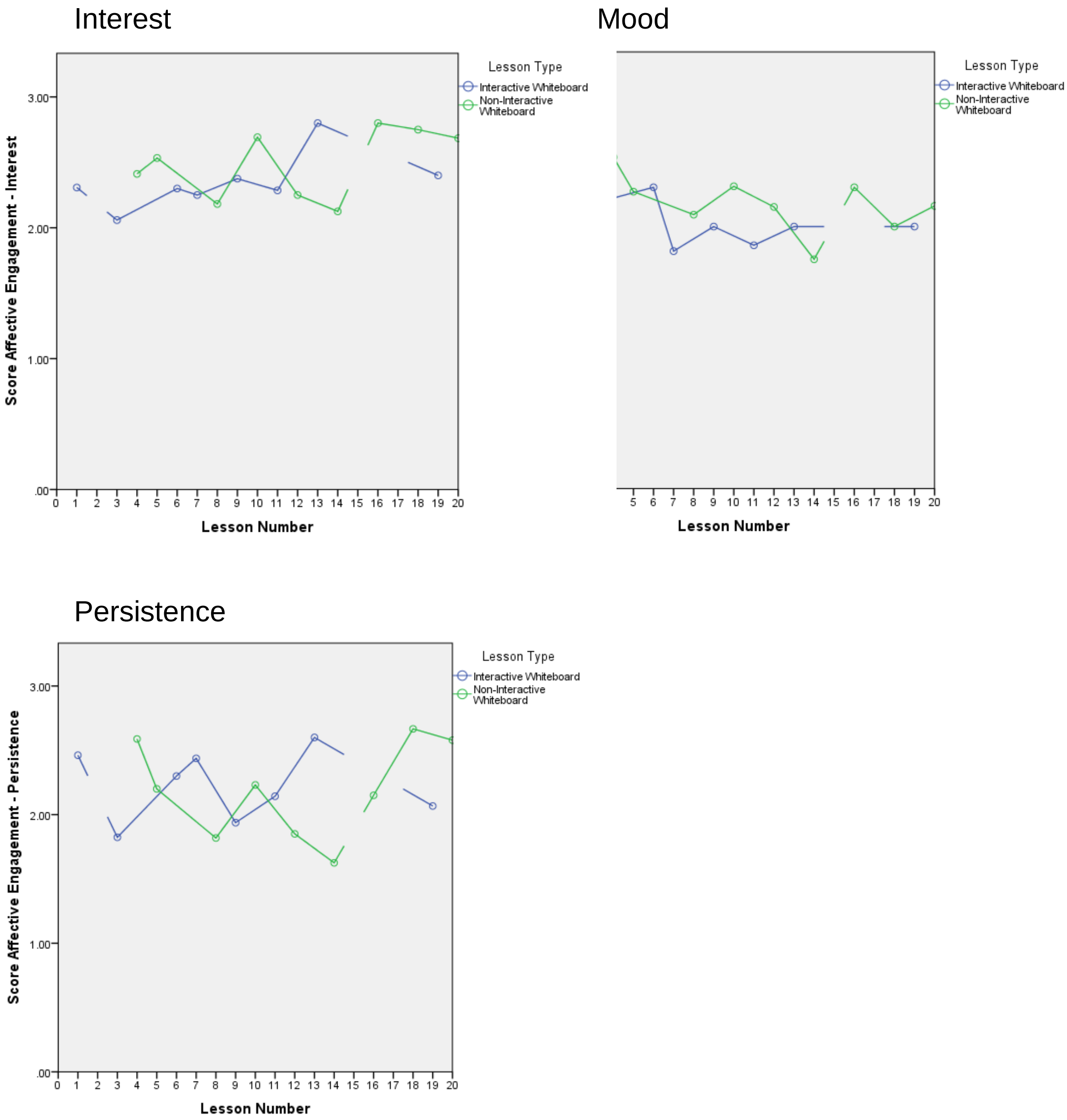


Figure 7-6

Corrine: Average Interest, Mood and Persistence per lesson^

Interest Scale: 3) shows sustained, intense interest; 2) shows some momentary, intense interest; 1) not upset, but lacks real interest; 0) sad, cries, pouts, angry, frustrated, tantrums. Mood Scale: 3) laughing appropriately, looking to interact with the teacher be part of the group; 2) smiling, looks pleased; 1) bored, expressionless; 0) child not enjoying self. Persistence Scale: 3) independently continued with focus activity, especially when faced with a difficulty/error; 2) attempted to continue on own, but required some assistance to continue with the focus activity; 1) made some effort to complete the focus activity with assistance, no effort when persistence required; 0) no attempt to complete activity when faced with an error/difficulty.

^Outlier Lesson 17 removed

The PND score analysis support the mean scores presented in Table 7-5, where Corrine indicated a minimal preference towards the non-IWB in interest, mood and towards the IWB in persistence, all scoring at 66.67%. The randomisation test results showed the probability values of RSS scores of 0.84 for interest, 0.56 for mood and 1.64 for persistence, none of which are statistically significant at $\alpha < .05$.

Cognitive Engagement

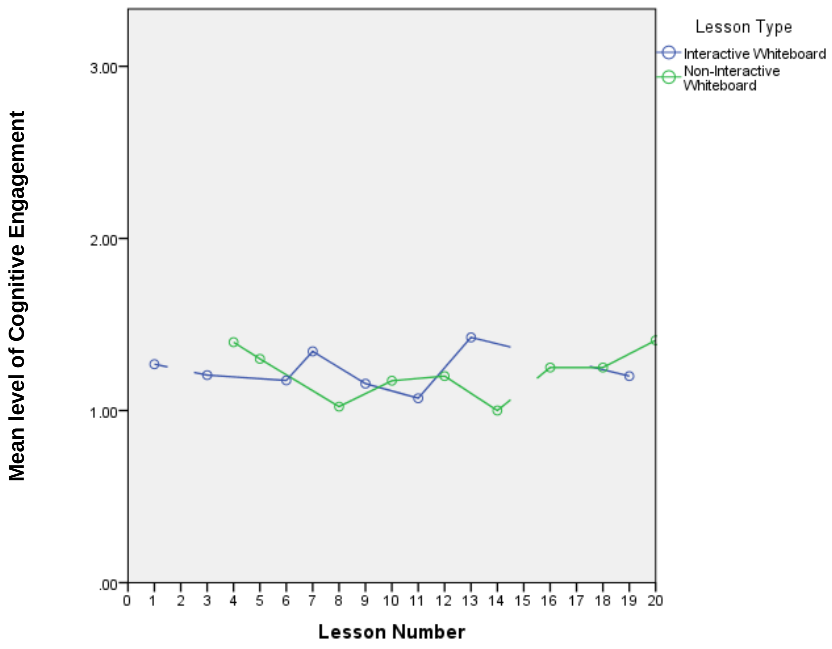


Figure 7-7
Corrine: Mean level of cognitive engagement per lesson^
Cognitive engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours
^Outlier Lesson 17 removed

Figure 7-7 represents the average cognitive engagement score per lesson across both conditions. Corrine's observed cognitive engagement behaviours were in the mildly negative range and the overall trend was relatively flat. The overall mean scores for cognitive engagement in the two conditions presented in Table 7-2, were very similar, with the IWB mean being 1.23 (range 1.07 – 1.43) and the non-IWB mean 1.22 (range 1.00 –

1.41). Neither the PND analysis, nor the RSS value, indicated a difference between the two conditions at 50% and 0.26 (α < .05).

Interactive Whiteboard Non-Interactive Whiteboard

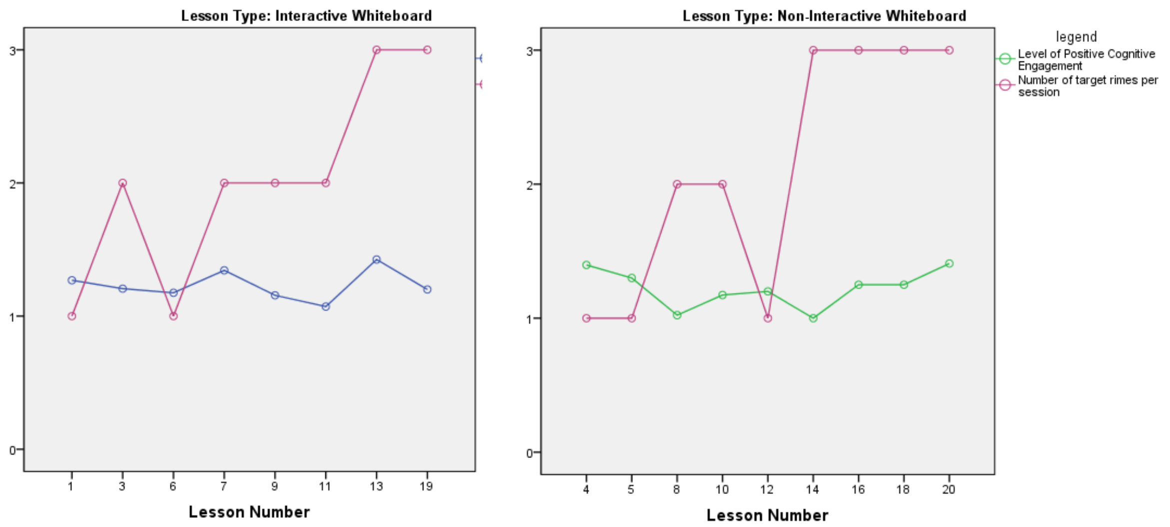


Figure 7-8
Corrine: Cognitive engagement and number of rimes per lesson per IWB and non-IWB conditions^
^Outlier Lesson 17 removed

As indicated by the range of scores (Table 7-2), Corrine's cognitive engagement levels did not fluctuate greatly across the lessons. Figure 7-8 displays the mean scores across the lessons mapped against the introduction of new rimes. Cognitive engagement in the IWB condition saw very little change when a new rime was introduced, whereas, in the non-IWB condition there was a drop in cognitive engagement on the introduction of a new rime in lesson 8, but no change in lesson 12 when the three rimes were presented in the lesson. This reflects the pattern observed in the previous two engagement constructs of task and affective engagement.

Individual Elements of Cognitive Engagement

Table 7-6
Corrine: Average Cognitive Engagement behaviours per lesson

	Selection		Elaboration		Monitoring		Problem Solving	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB^	2.54 (0.32)	1.94 – 2.90	0.06 (0.11)	0.00 – 0.30	0.22(0.32)	0.00 – 0.94	2.09 (0.33)	1.86– 2.70
Non-IWB	2.63 (0.25)	2.25 –3.00	0.16 (0.19)	0.00 – 0.45	0.11(0.21)	0.00– 0.59	1.99 (0.33)	1.45– 2.42

^. Outlier Lesson 17 removed.

The means of the four elements that contribute to the Cognitive Engagement construct are displayed in Table 7-6. The means for the selection element, in both conditions, indicated that Corrine was able to independently select the appropriate material to complete the task. Very little difference between the two conditions was evident.

For the elaboration element, the mean was higher in the non-IWB condition. However, in both conditions elaboration was in the negative range of scores, indicating that Corrine made few connections between the material or tasks presented and prior knowledge or experience.

The monitoring element showed a similar result to that of elaboration, where in both conditions, there was very little sign of recognising an error had been made, or of attempts at self-correcting or of asking questions to clarify either the task or the result.

Corrine's attempts at problem solving were more positive in both conditions, indicating that she would attempt to solve the problem presented independently, but was not always correct in her attempts.

Selection

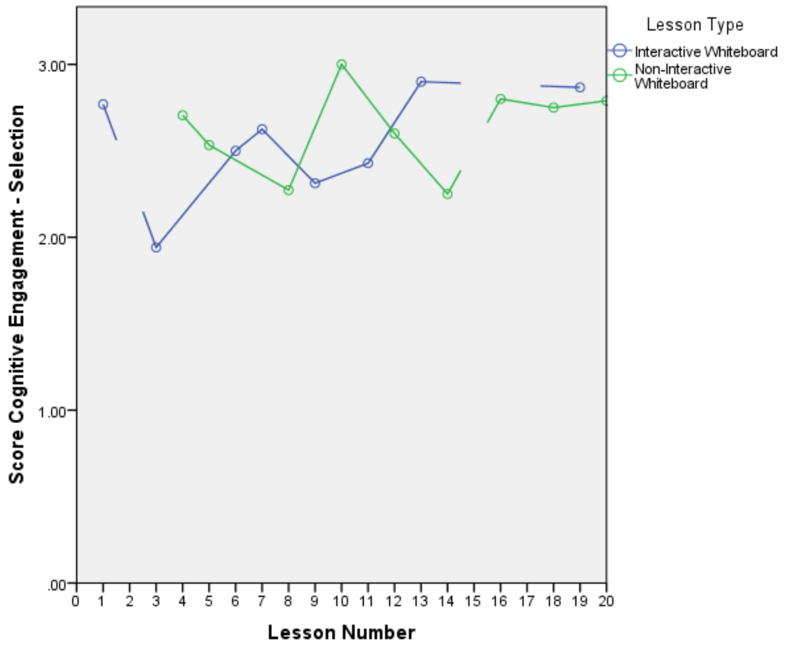


Figure 7-9
Corrine: Average appropriate selection attempts per lesson^
Selection Scale scores: 3) independently selects correct material to complete the task; 2) selects some or part of the material, but not enough to complete the task; 1) selects material, but inappropriate to the task; 0) no sign of selecting the material.
^. Outlier Lesson 17 removed

Corrine's ability to independently and correctly select the appropriate materials to complete the task fluctuated across the twenty sessions, between selecting some or part of the material to being independent and successful in the material selection (see Figure 7-9). The means slightly favour the non-IWB condition, and on calculation of the PND, Corrine indicated a minimal preference towards the IWB (57%). The RSS value was 1.22 ($\alpha < .05$), not a statistically significant result, indicating no preference between the two conditions.

Elaboration

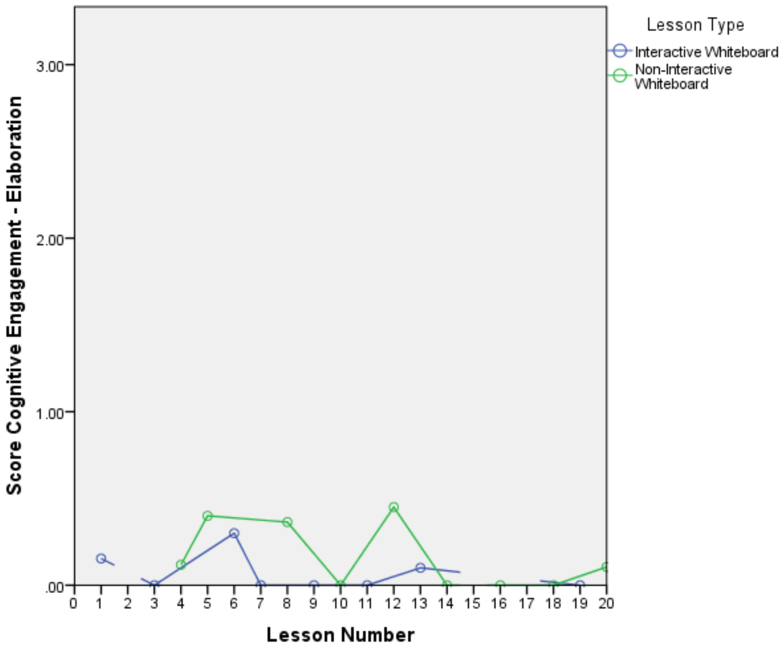


Figure 7-10

Corrine: Average elaborated verbal responses per lesson^

Elaboration Scale: 3) independently connects material with an original elaboration, extends ideas, creates other relevant word. Can include non-verbal responses; 2) with or without prompting, connects material with previous learning; 1) with or without prompting, attempts to elaborate, but no clear connection with the material; 0) no sign of connecting material to prior learning.

^. Outlier Lesson 17 removed

Corrine exhibited very few elaborations during the 20 lessons in either condition, (as depicted in Figure 7-10). The mean score for the IWB condition was 0.06 (range 0.00 – 0.30) lower than the non-IWB condition where the mean score was 0.16 (range 0.00 – 0.45), both extremely low. Graphically, it appears the non-IWB condition showed slightly more elaboration than the IWB condition, however the PND analysis does not support this observation, with the scores on the comparable lessons being evenly matched at 33.3% each. The randomisation test analysis showed the probability value of a RSS score of 0.37 ($\alpha < .05$), not statistically significant.

Verbal elaborations

Verbal responses were the unsolicited language emitted by Corrine during the recording periods throughout the lessons, either elaborating upon the idea being presented in the task or irrelevant to the task. Figure 7-11 depicts the occurrence of the additional language spoken by Corrine across the 20 lessons and the two conditions. The figure below depicts verbal elaborations and may appear different to that depicted in Figure 7-10 as that figure includes non-verbal elaborations.

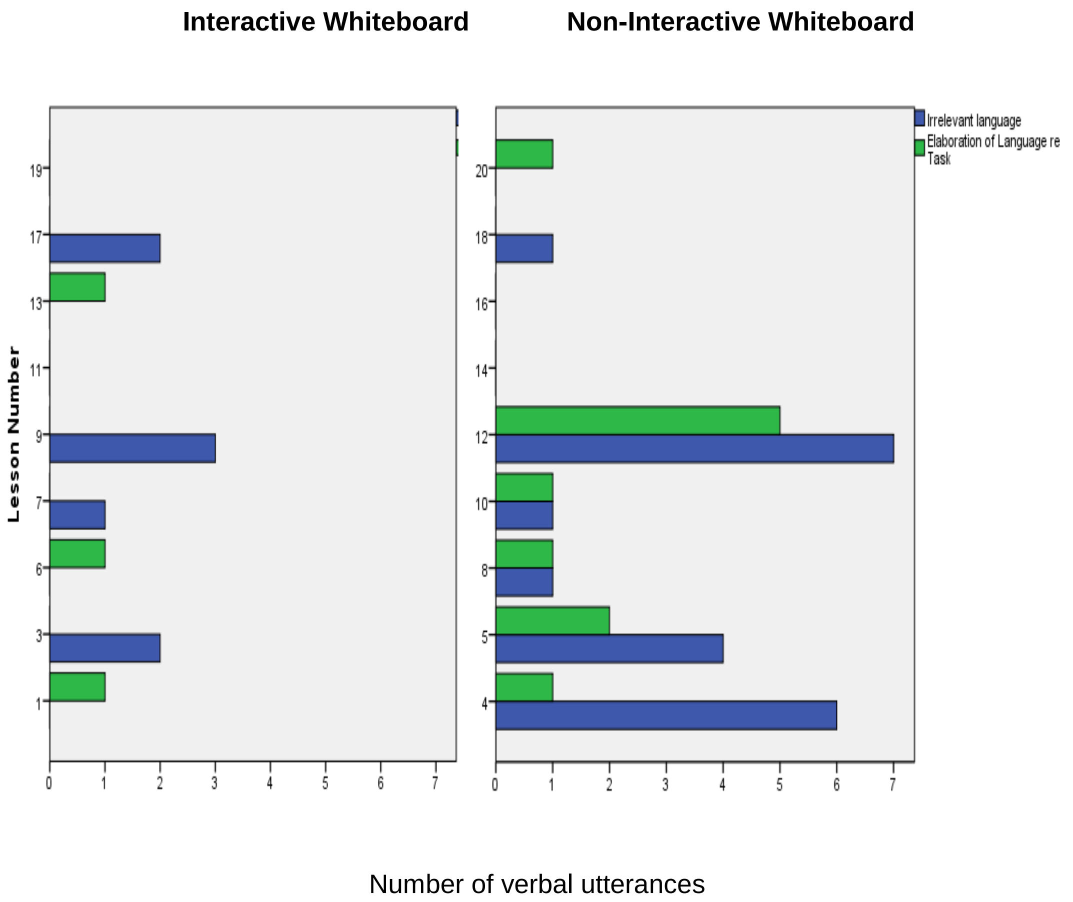


Figure 7-11
Corrine: Frequency of irrelevant and elaborated language per condition and lesson
IWB frequency =3 elaborated, 8 irrelevant; non-IWB frequency = 11 elaborated, 20 irrelevant

It can be observed that considerably more language, both elaborated relevant and irrelevant, was produced during the non-IWB lessons, peaking in lesson 12, the first lesson of the third rime. Seven of Corrine's responses in lesson 12 were coded as irrelevant, the majority of which occurred five minutes into the lesson after failed attempts at sounding and blending the new rime. Six of the seven irrelevant responses were of her whistling and singing rather than sounding, blending and writing. She would also call herself *'dumb'* if she was struggling with a task. Her relevant elaborated responses in this lesson relate to her saying rhyming words with the /ed/ rime with words such as dead and head. She also created a previously learnt word and a new word out of the magnetic letters, sounding out the letters as she placed them in their correct position. These three coded elaborated responses may also have been avoidance behaviours as she was actively avoiding looking at and attempting to sound and blend the new words being presented.

The majority of Corrine's elaborated relevant language in the non-IWB condition was connecting the target words or letters to other words that rhymed or started with those letters (10 of the 16 elaborations). Other elaborated responses indicated her comprehension or understanding of the word, such as linking the word /dip/ to '*dip and biscuits'*. In the IWB condition, the frequency of elaboration was less than that produced in the non-IWB condition, eight irrelevant utterances and only three elaborated, unsolicited, relevant responses. Corrine's elaborated relevant responses would indicate comprehension such as '*I play tennis (not cricket)'* in lesson 1, recalling /b/ words in lesson 6, and in lesson 13 where she announced she (finally) understood the difference between /bag/ and /bat/. Corrine's irrelevant comments were around task avoidance such as *'No, I will colour'* when a new writing task was introduced, or about changing the colour of the pen such as *'I want purple', 'I want a better red', or 'No, a different colour'.*

Monitoring

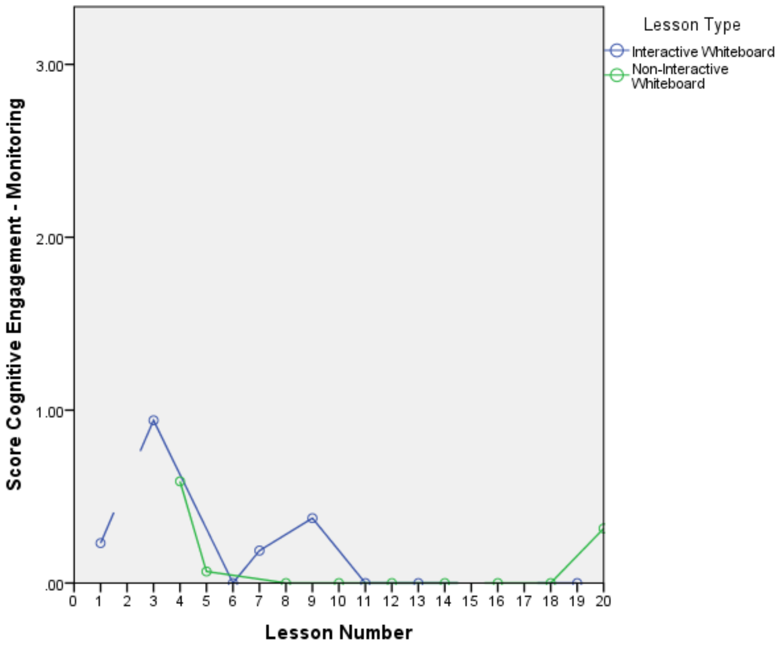


Figure 7-12
Corrine: Average monitoring attempts per lesson^
Monitoring: 3) with no prompting, self-corrects, asks relevant questions; 2) with prompting recognises error, some comments related to error and/or task. No relevant questioning; 1) with prompting, shows some recognition of error, but no clear connection or questions related to task; 0) no sign of self-correction, questioning, recognition of error.
^. Outlier Lesson 17 removed

The general level of self-monitoring across both conditions was very low. Corinne rarely showed any sign of error recognition, or asked questions or self-corrected. Figure 7-12 depicts the average attempts per lesson, and shows that in eleven lessons she did no self-monitoring or showed recognition of an error, even with prompting from the researcher. When Corrine did monitor her attempts, there was no questioning for clarification. Rather there was visual recognition that letters were written incorrectly when on the IWB, or magnets or letters were '*upside down*' in the non-IWB condition. Other self-correction attempts made in the IWB condition were looking at the already written word to check the order of letters when she was writing, and looking at words to pictures and erasing any incorrect lines before joining the two together with the pen. In lesson 9 Corrine recognised she had already used the word /mat/, so she reallocated /rug/ to the initial sentence so she could use the word /mat/ in the current sentence. During lesson 5, a non-IWB task, Corrine attempted to self-correct the placement of the letters /i/n/ by changing them to /n/i/ and announced '*the /n/ goes first*', and twice in lesson 20 she self-corrected the reading of the word /fin/ to /fed/.

Table 7-6 displays the average self-monitoring attempts per lesson. Self-monitoring occurred slightly more often in the IWB condition with a mean of 0.22 (range 0.00 – 0.94) than the non-IWB with a mean of 0.11 (range 0.00 – 0.59). The PND analysis suggested little difference between the two conditions, as no self-monitoring was observed in half of the lessons, a very minimal preference towards the IWB condition, three lessons against two in the non-IWB condition. A RSS score of 1.09 at $\alpha < .05$ indicates no statistical difference for this element between the two conditions.

Problem Solving

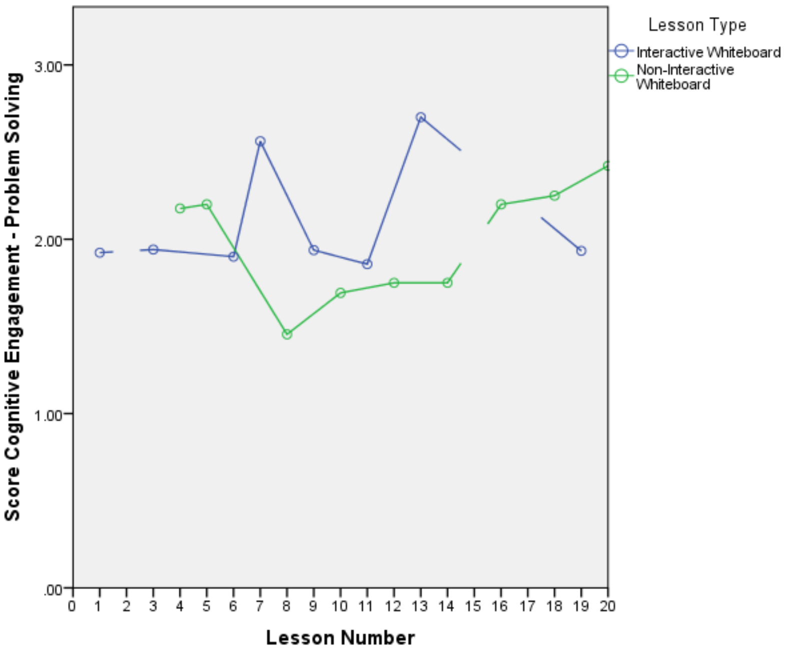


Figure 7-13
Corrine: Average attempts at problem solving per lesson^
Problem Solving scores: 3) carries out task spontaneously and accurately; 2) attempts on own, partially correct; 1) some progress with much assistance; 0) no progress or not required.
^. Outlier Lesson 17 removed

The overall level of problem solving attempts indicated in Figure 7-13 fluctuate around the level where Corrine attempted to problem solve independently, but was not always correct, regardless of the condition. The mean for the IWB condition was 2.09 (range 1.86 – 2.70), slightly higher than the non-IWB mean of 1.99 (range 1.45 – 2.42; see Table 7-6). The PND analysis showed Corrine to be minimally more successful in problem solving in the IWB condition with a score of 62.5%. On running the randomisation test, a probability value of 1.65 was calculated, a result that was not statistically significant.

The type of problem solving strategies utilised by Corrine across the IWB lessons were predominantly the use of pictures to help ‘read’ the text or guessing the words on recognition of the initial or final letter. For example, when presented with a picture to describe the word /hug/, cuddle would be offered as an answer; on presentation of /t/a/g/, /girl/ would be a response or she would respond with a repertoire of words learnt over the lessons, such as /tug/, /bag/, or /rag/. When using the Reading Doctor™ program, she would press on the icons to sound for her, listening to the aural prompts or listen to the researcher's prompts. This strategy would become problematic when using the Reading Doctor™ program, as the aural prompts ceased after the first three correct answers, making Corrine read or sound and blend for herself. When the words presented all started with a different grapho-phoneme, she was more capable of successfully completing the task, but when there was more than one word with the same onset, such as bag/bug/bat, she encountered many problems as she was required to look past the initial sound. Rarely did Corrine independently use the sounding and blending skills taught throughout the lessons.

In the non-IWB lessons, Corrine predominantly used the same strategies as in the IWB condition, using the picture prompts or guessing. Again, when guessing, she would use the first or final letter and draw from her memory a word that began with that letter. For example, on presentation of /fin/, she would respond with fireman, finger, fish, fun, or fan; on presentation of /l/i/p/ a response of /puppy/ was not uncommon. When trying to recall words that had been worked with, she would often close her eyes and tap her head. When asked what she was doing her response would be "*I'm thinking/sounding in my head'.* Another commonly used strategy would be to listen to the researcher's prompts rather than sound out letters/words for herself. A strategy used more often in the non-IWB condition was that of context. Corrine would use the sentence to gain an understanding of the missing word, but would often then guess a word (that made sense) rather than try and use a target word in the sentence. She also independently sounded aloud more often in this condition.

Cognitive Load

Table 7-7
Corrine: Number of rimes per lesson, number of target words per lesson and the introduction of new rimes

Lesson No.	1	2	3	4	5	6	7	8	9	10
IWB	NR		NR		NR					
Sequence	L1	L2	L3	L6	L7	L9	L11	L13	L17	L19
No. rimes	1	1	2	1	2	2	2	3	3	3
No. words	4	4	8	4	8	7	7	9	4	15
Non-IWB	NR		NR		NR					
Sequence	L4	L5	L8	L10	L12	L14	L15	L16	L18	L20
No. rimes	1	1	2	2	1	3	3	3	3	3
No. words	3	3	7	7	3	11	11	11	11	11

NR = new rime introduced

Corrine was introduced to three rime families across the two conditions. The order of the lessons, and the number of rimes presented each lesson are presented in Table 7-7.

On analysis of Corrine's non-task related language, it became evident that this was an indicator of her becoming disengaged with the task presented to her. The timing of her irrelevant responses coincided with Corrine being introduced to a new task or occurred after struggling for an average of six minutes in either condition, and were indicative of her engagement levels falling in that or the next recording period. To be more precise, in the IWB condition, the irrelevant language preceded a fall in engagement across all three constructs, whereas irrelevant language occurred in the non-IWB condition in the recording period where engagement fell across all three engagement constructs, a possible indicator of cognitive overload and an inability to cope with the cognitive demands being placed upon her. Supporting this argument, Corrine's engagement levels usually rose again when a familiar task was introduced in which she could experience success.

The re-engagement displayed by Corrine reinforced the need for short exercises/tasks to enable novel tasks to be alternated with a familiar task, thus reducing the cognitive demand placed upon her.

Other behaviours that indicated that Corrine was 'over loaded' varied across the conditions. In the IWB condition, she would play with the features of the board – change the colour of the pen, the style of the pen, the width of the pen, erase, scribble, change the shape of the letters/icons, move pictures around the board or place her shadow in the way of the projector so the images could not be seen. She was able to 'lose' the screen by deleting, minimising or shutting it down, and physically she would lie on the floor and try to adjust the height of the IWB which was fixed to the wall. Twice she asked *'How long will this take?'* when she was experiencing difficulty.

The behaviours Corrine displayed when faced with novel or difficult tasks in the non-IWB condition were often verbal, with responses such as *'Too hard'*, *'I don't know how',* '*Can we do something else?'*, and *'I forget them'.* She would also sing and whistle. However, she would also engage in non-verbal behaviours such as going under the desk and getting up out of her seat. Again, by moving between difficult or novel tasks to more familiar tasks, Corrine was able to re-engage with the activities in the lesson.

Corrine also performed more successfully when the computer program or researcher sounded the letters, leaving her to concentrate on blending the sounds together. When she sounded the letters out, a usual response in an attempt to blend would be drawing on the final sound uttered, indicating a recency effect or short-term memory issues, of only being able to retain the final sound uttered and connect it to existing knowledge.

Table 7-8
Corrine: Pearson's correlation comparing the relationships between the number of target rimes presented and task, affective and cognitive engagement scores^

	Task Engagement	Affective Engagement	Cognitive Engagement
IWB^	.312	.088	.305
Non-IWB	.143	-.009	-.199

N = 9

^. Outlier Lesson 17 removed.

The correlations presented in Table 7-8 suggest there was a moderate correlation between the task and cognitive engagement constructs and the number of rimes presented when working on the IWB. The correlations calculated in the non-IWB condition suggest a weak positive relationship between the number of rimes presented and positive task engagement, and a weak negative relationship between the number of rimes presented and the effect on cognitive engagement. There was no relationship between the number of rimes and affective engagement in either condition. No correlations reached a level of statistical significance, and it could be surmised that the introduction of new rimes did not affect engagement levels in any consistent way. However, as previously mentioned, Corrine was able to re-engage with a lesson when tasks were alternated between novel and familiar, possibly masking the effect of increased cognitive load. For example, when a new rime was introduced to Corrine it would always be introduced with a familiar task – the novel aspect being the new rime. This task would then be followed by another familiar activity with the researcher providing the oral prompts to enable Corrine focus on the problem solving rather than all the elements of the task.

Rime Acquisition

Corrine was introduced to three rime families across both conditions. The rimes were introduced within the same time span across the two conditions, indicating no condition led to a faster acquisition of rime to the other. No additional rime families were introduced as Corrine required the extra time with all the rimes being presented together to help her focus on the whole of the word when attempting to decode similar looking words.

Summary

Table 7-9
Corrine: Summary of engagement behaviours^

Type of Engagement Behaviours	Individual Engagement Elements	Visual Analysis	PND Effect	Randomisation Test	Summary
Task engagement		no visual difference	moderate IWB > non-IWB	no significance	no difference
	Activity related	no visual difference	moderate non-IWB > IWB	no significance	no difference
	Eye contact	no visual difference	minimal IWB > non-IWB	no significance	no difference
Affective engagement		no visual difference	no relationship	no significance	no difference
	Interest	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Mood	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Persistence	no visual difference	minimal IWB > non-IWB	no significance	no difference
Cognitive engagement		no visual difference	no relationship	no significance	no difference
	Selection	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Elaboration	non-IWB > IWB	no relationship	no significance	no difference
	Monitoring	IWB > non-IWB	minimal IWB > non-IWB	no significance	in favour of the IWB
	Problem solving	IWB > non-IWB	minimal IWB > non-IWB	no significance	in favour of the IWB

^Results shown with outlier Lesson 17 removed

Corrine's levels of engagement across the intervention averaged in the mid – high engagement levels in both task and affective engagement, and in the low, negative range for cognitive engagement. This indicated that Corrine was engaging with the tasks during the reading lessons and her general affect was of a positive nature. Where Corrine struggled was with her cognitive engagement.

The results presented above in Table 7-9 indicate there was no behavioural preference towards either condition. However, Corrine verbally indicated a penchant towards working on the IWB, stating in three of the non-IWB lessons that she wanted to be on the IWB. In lesson 4, she inquired as to what we were doing, and when she heard she was not going to be using the IWB, she dropped her chin to her chest and bowed her head. In lessons 10 and 16 she requested to use the IWB, with the request in lesson 16 resulting in a plea:

> '*I want the whiteboard. Please, pretty please!*'

Similar to Martin, Corrine's negative behaviour at the IWB was more extreme than when sitting at a table. She was more mobile; rolling on the floor, trying to adjust the height of the board; she was able to delete pages or items and shut down programs if she did not want to continue. It may be that working in the IWB condition gave a greater sense of control over the lesson than in the non-IWB lessons. Language production, whether it be relevant to the task or not, was more frequent in the non-IWB condition, more than double the verbal output produced in the IWB condition. This may be an important observation, as speech and language disorder impacts significantly on the student's ability to learn, particularly when connected to the acquisition of grapho-phonic knowledge.

The pre and post-test results indicate that some learning had occurred over the twenty lessons. Corrine was able to sound and blend, when prompted, and identify the target cvc word. The rimes were introduced at the same pace across the two conditions. Therefore it cannot be concluded that one form of delivery was more successful than the other in terms of engagement or achievement, just that she acquired some sounding and blending knowledge.

8. JACOB

Jacob, at the time of instruction was 6 years and 7 months of age, and had been at school for 5 terms. The first four of these terms had been in a mainstream setting, after which he was moved to a small special class setting once a vacancy arose. Jacob had been identified with Global Developmental Delay and severe language delay in kindergarten (pre-school).

Lesson History

Jacob presented as a happy student with a desire to please everyone with whom he worked. This would generally manifest through him consistently asking '*What now?', 'What you want me to do?' or 'What next?*' resulting in him not attempting to anticipate what would follow or simply failing to 'have a go' without adult guidance. Jacob's ability to communicate was hampered by a significant severe language delay which resulted in him being unable to pronounce the beginning of words when faced with blended sounds, and dropping the initial letter when speaking. At the time of the reading intervention, he was being supported by the DECS Speech Pathologist who would withdraw him from class once a week to work with him on an individual basis.

There were also major building works occurring at the school, resulting in continuous noise from tools such as jack hammers and banging (nail guns). His class was directly adjacent to the building construction site, however, he generally participated in the lessons without commenting or being obviously affected by the noise.

Pre-test and post-test reading task results

The letters used in the pre and post-test were those identified in the Method chapter. Sixteen letters were presented verbally and then visually. Due to Jacob's inability to identify the letters in either print or aural format in the pre-test, no cvc words were presented.

As Jacob was unable to identify the individual letters, the resulting intervention differed from the previous case studies, and focused on the teaching of individual letters, verbally and visually. The letters were also combined to make words to give relevance to his developing graphophonic knowledge.

On completion of the 20 lessons, Jacob successfully identified 75% of the letters taught when the letters were presented verbally. He struggled with the verbal presentation of /f/ and /p/, recalling /d/ and /f/ respectively. On the presentation of the letters in print, Jacob successfully identified 62.5% of the letters taught, being unable to identify /g/, /n/ and /f/ in print, confusing /g/ with /m/, a letter not taught, /n/ with /p/ and /f/ with /t/, both letters taught in the same condition. The results of the pre and post-tests are presented in Table 8-1 and Table 8-2 and a condensed version of the pre and post-test results identifying only the letters taught is depicted in Table 8-3.

Table 8-1
Jacob's Pre and Post test results: Oral presentation of letter

Letter presented verbally*	Pre-test	Percentage correct	Post test	Percentage correct
		12.5%		56.25%
a**	**e**	**x**	**a**	✓
b	p	x	o	x
c	g	x	c	✓
d	f	x	r	x
e	c	x	c	x
f**	**s**	**x**	**d**	**x**
g**	**a**	**x**	**g**	✓
i**	**o**	**x**	**i**	✓
l	l	✓	-	x
m	e	x	m	✓
n**	**a**	**x**	**n**	✓
o	n	x	n	x
p**	**l**	**x**	**f**	**x**
r	b	x	r	✓
s**	**s**	✓	**s**	✓
t**	**c**	**x**	**t**	✓

* Letters not reported in order presented to student.

Randomisation: List 5 on pre-test and List 1 on post-test. See Appendix D

** Letters taught

Table 8-2
Jacob's Pre and Post test results: Print presentation of letter

Letter presented in print*	Pre-test	Percentage correct	Post test	Percentage correct
		0%		43.75%
a**	**m**	**x**	**a**	**✓**
b	m	x	p	x
c	d	x	t	x
d	1	x	p	x
e	the	x	c	x
f**	**-**	**x**	**t**	**x**
g**	**m**	**x**	**m**	**x**
i**	**8**	**x**	**i**	**✓**
l	r	x	l	✓
m	the	x	m	✓
n**	**b**	**x**	**p**	**x**
o	m	x	o	✓
p**	**m**	**x**	**p**	**✓**
r	a	x	d	x
s**	**8**	**x**	**s**	**✓**
t**	**1**	**x**	**t**	**✓**

* Letters not reported in order presented to student.
Randomisation: List 5 on pre-test and List 1 on post-test.
** Letters taught

Table 8-3
Jacob's Pre and Post test results: Letters taught

Letter presented*	Verbal pre/post test	Percentage correct pre/post	Print pre/post test	Percentage correct pre/post
		1:8/6:8 12.5%/ 75%		**0:8/5:8 0%/62.5%**
a	e/a	x/✓	m/a	x/✓
f	s/d	x/x	-/t	x/x
g	a/g	x/✓	m/m	x/x
i	o/i	x/✓	8/i	x/✓
n	a/n	x/✓	b/p	x/x
p	l/f	x/x	m/p	x/✓
s	s/s	✓/✓	8/s	x/✓
t	c/t	x/✓	1/t	x/✓

* Letters not reported in order presented to student.
Randomisation: List 5 on pre-test and List 1 on post-test.

Anecdotally, Jacob's teacher reported six months later that he knew most of his letters and wanted to learn letter combinations. With support, he was beginning to blend and was finding it much easier to learn sight words. He was using a personal dictionary to write short stereotypic sentences quite independently.

Engagement

The means were calculated for the ratings of each of the engagement behaviour constructs and are presented in Table 8-4. Engagement behaviours were coded for each of the 20 lessons.

Table 8-4
Jacob: Means and Ranges for Engagement Behaviours

	Task Engagement Behaviours		Affective Engagement Behaviours		Cognitive Engagement Behaviours	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.79 (0.20)	2.38 – 3.00	2.39 (0.19)	2.08 – 2.79	1.27 (0.13)	1.02 – 1.49
Non-IWB	2.75 (0.20)	2.32 – 3.00	2.39 (0.34)	1.62 – 2.81	1.32 (0.15)	1.09 – 1.51

The average engagement level was high in the task engagement behaviour construct, with a similar mean and range of scores in both the IWB and non-IWB condition, 2.79 (range 2.38 – 3.00) and 2.75 (range 2.32 – 3.00) respectively. The affective engagement behaviour means were identical for both conditions, at 2.39, indicating that he was mildly positively affectively engaged across the lessons. However, the range of scores varied more in the non-IWB condition (1.62 – 2.81) than the IWB condition (2.08 – 2.79), indicating Jacob showed greater affective variability whilst working in the non-IWB condition. Both means in the cognitive engagement behaviour construct were in the mildly negative range of 1.27 (range 1.02 – 1.49) for the IWB condition, and slightly higher in the non-IWB condition with a mean of 1.32 (range 1.09 – 1.51).

Table 8-5
Jacob: Correlations between ratings for the three engagement constructs of task, affect and cognition across the IWB and Non-IWB conditions.

Lesson Type		Level of Affective Engagement	Level of Cognitive Engagement
IWB N= 10	Level of Task Engagement	.777**	.441
	Level of Affective Engagement		.309
Non-IWB N=10	Level of Task Engagement	.885**	.582*
	Level of Affective Engagement		.763**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The correlations shown in Table 8-5 indicate a very strong, positive relationship between the ratings for task and affective engagement in the IWB condition, indicating that when Jacob was positively task engaged he was also positively affectively engaged. However, the correlation between the ratings for cognitive engagement and task and affective engagement in the IWB condition are moderately positive, and are not statistically significant.

The correlations for the non-IWB condition indicate very strong, positive relationships among the ratings for affective engagement and task and cognitive engagement, and strong for task and cognitive engagement. The three relationships are statistically significant. These results indicate Jacob was positively engaged across the three constructs during lesson time.

Task Engagement

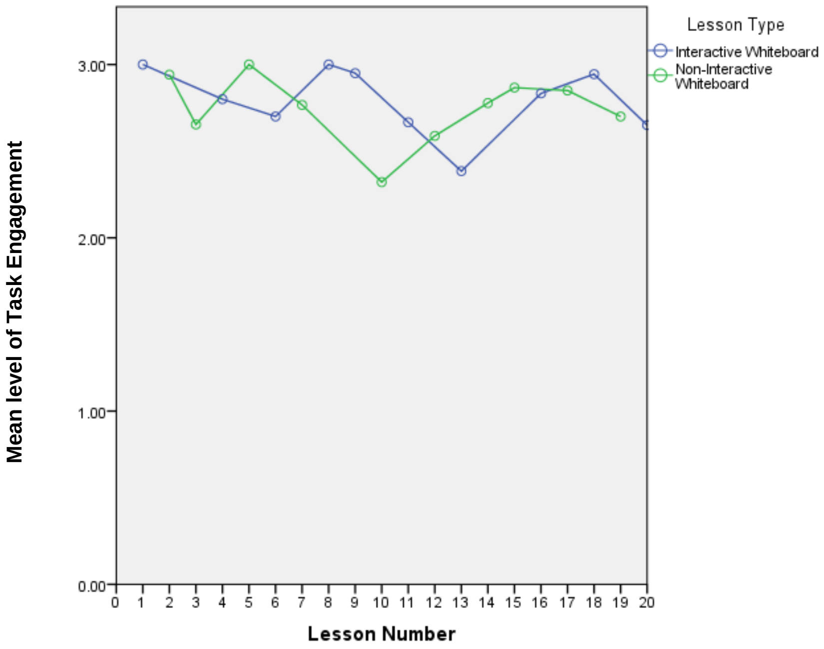


Figure 8-1
Jacob: Mean Level of Task Engagement behaviours per lesson
Task engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

Figure 8-1 depicts the mean level of task engagement behaviours that Jacob displayed across the 20 lessons involving the two conditions. The diagram shows that Jacob was highly task engaged across both conditions with a very slight negative trend across time. As previously stated, there was very little difference between the mean and range of scores between the two conditions (see Table 8-4). There were many overlapping points across the lessons, making visual analysis difficult. The PND analysis showed a minimal effect with slightly higher task engagement behaviours (60%) in the IWB lessons. The RSS value was 0.69 ($\alpha < .05$), indicating no statistical difference between the two conditions.

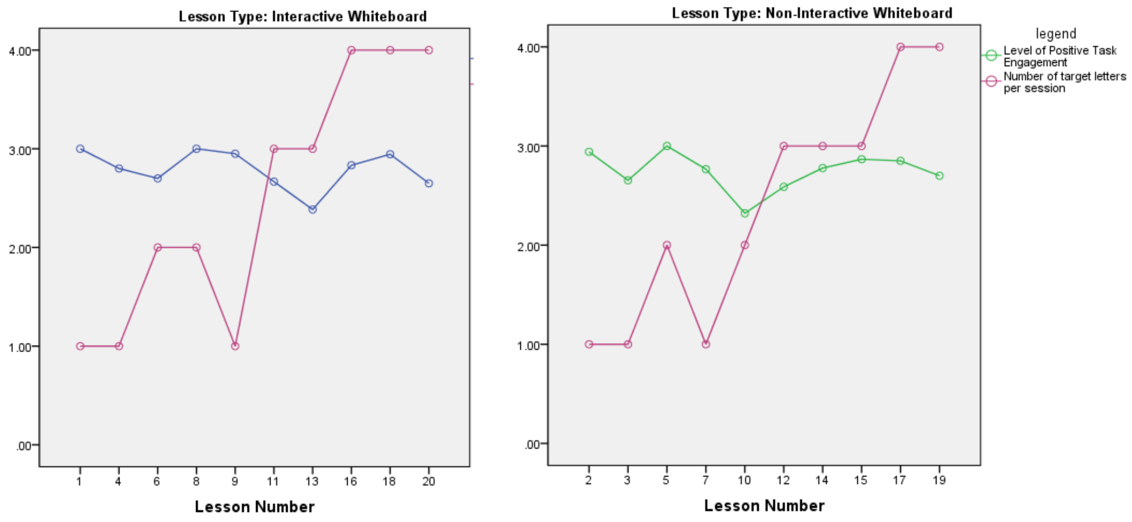


Figure 8-2
Jacob: Task engagement and number of letters per lesson per IWB and non-IWB conditions

Figure 8-2 compares task engagement behaviour ratings across the IWB and non-IWB conditions in relation to the number of letters presented to Jacob. The IWB graph depicts a drop in task engagement on the introduction of the second and third letters (L6 and L11), and a rise in task engagement when the fourth letter was introduced (L16). The lowest point however, was not when a new letter was introduced (L13), it was the second time Jacob had encountered /a/. In this lesson he spent much of the time changing the colour of the IWB pen and placing his body between the projector and the board to create shadows, making it difficult to see the task on the board. The non-IWB graph indicates there is no clear trend associated with the introduction of new letters. The lesson in which the second letter was introduced saw an increase in task engagement behaviour (L5), the third letter a fall (L10), which was also the lowest point across the lessons, and when the fourth letter was introduced, engagement was relatively stable from the previous lesson (L17). Lesson 10 was a lesson in which Jacob expressed he was '*really tired'.*

Regardless of the condition or the number of letters presented, Jacob's average task engagement behaviour was rated to be in the mostly positive range.

Individual Elements of Task Engagement

Table 8-6
Jacob: Average Task Engagement Behaviours per lesson

	Task Engagement Behaviours – activity related behaviour		Task Engagement Behaviours – eye contact	
	M (SD)	Range	M (SD)	Range
IWB	2.79 (0.21)	2.38 – 3.00	2.79 (0.20)	2.38 – 3.00
Non-IWB	2.76 (0.21)	2.29 – 3.00	2.74 (0.19)	2.36 – 3.00

The means presented in Table 8-6 show Jacob's activity related behaviour and eye contact to be in the high range of behaviours in both conditions. There was very little difference between the mean and the range of scores in the IWB and non-IWB conditions, indicating that Jacob showed similar levels of engagement in both conditions across the lessons.

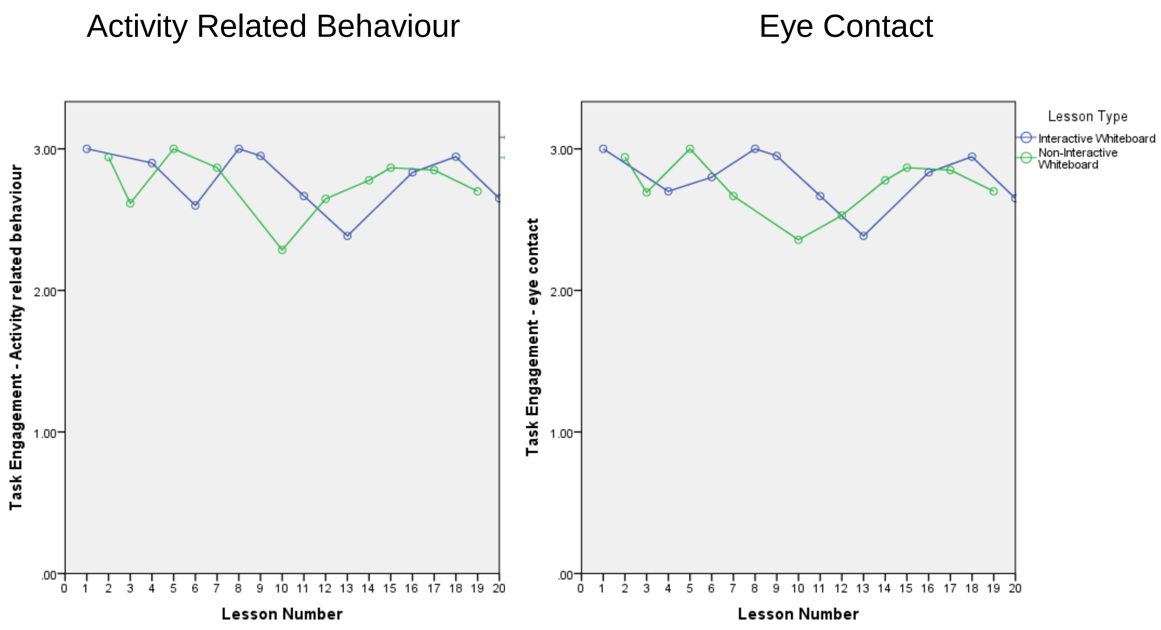


Figure 8-3
Jacob: Average Activity Related Behaviour and Eye contact.

The individual graphs presented in Figure 8-3 show the breakdown of the elements that make the task engagement behaviour construct. There are many overlapping data points making visual interpretation of the graphs difficult. The PND analysis indicated Jacob was minimally more task engaged in activity related behaviour in 60% of lessons in the IWB condition, and no preference to either condition with eye contact was indicated with a score of 50%. No statistically significant differences were was found when the randomisation tests were performed with a probability value of a RSS value of 0.77 for activity related behaviour and 0.68 for eye contact, both at $\alpha < .05$.

Affective Engagement

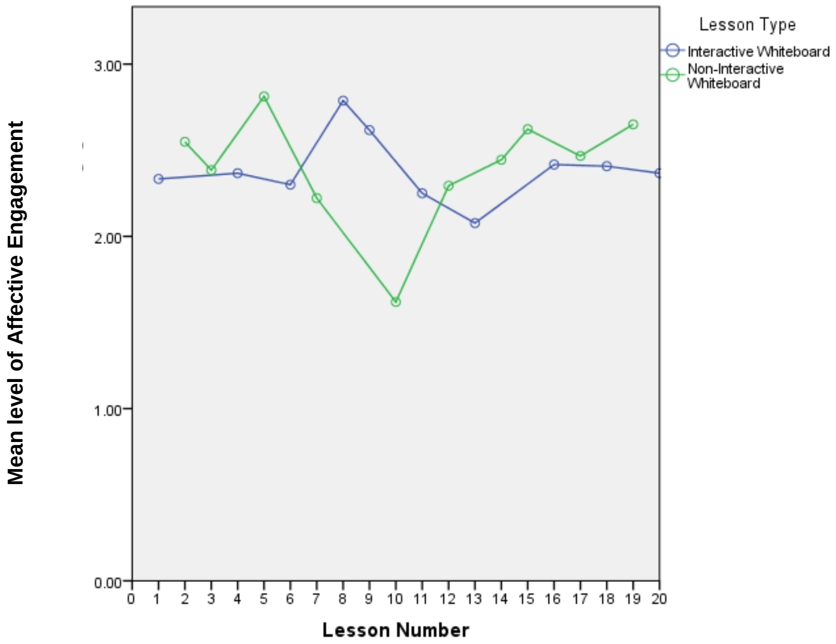


Figure 8-4
Jacob: Mean Level of Affective Engagement Behaviours per Lesson
Affective engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours.

The overall level of affective engagement was in the mildly positively engaged range for both conditions, with the mean scores being identical at 2.39 (as shown in Table 8-4). However, the non-IWB condition had greater variability in the range of scores as depicted in Figure 8-4. Jacob's affective engagement in the IWB condition varied from a rating of 2.08 – 2.79 and in the non-IWB condition from 1.62 – 2.81. The lowest affective engagement rating was in lesson 10, a non-IWB lesson, a lesson in which he expressed how tired he was. The first of the two higher rated lessons in the IWB condition, lesson 8, saw the introduction of the Reading Doctor™ software, a lesson in which he responded very well to the computer generated encouragement by laughing and expressing '*wow'* and jumping up and down when scores appeared on the correct selection of the letters. In lesson 9, the second of the higher rating IWB lessons, Jacob appeared very happy throughout the lesson. On calculation of the PND, a moderate preference for the non-IWB condition became evident with Jacob scoring higher in 80% of the lessons, which is supported by the visual representation of the data in Figure 8-4. However, the randomisation test analysis indicated no statistically significant difference between the condition (RSS = 1.30, α < .05).

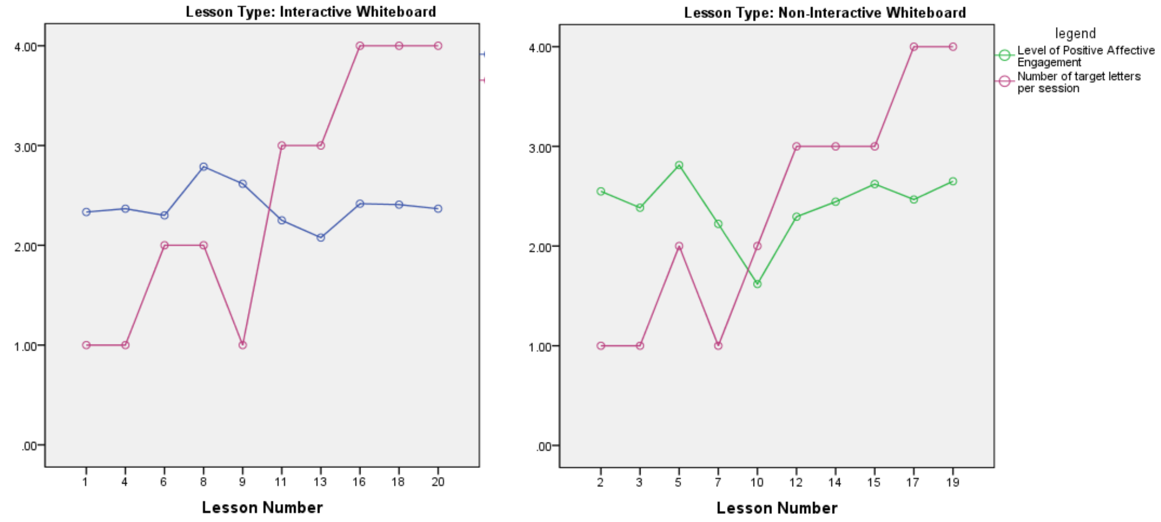


Figure 8-5
Jacob: Affective engagement and number of letters per lesson per IWB and non-IWB conditions.

The introduction of new letters did not negatively affect Jacob's affective engagement, nor did the increasing number of letters per lesson. In the IWB condition, the ratings recorded on the introduction of a new letter ranged from 2.67 - 2.83 indicating he remained positively affectively engaged as new letters were introduced to him. A similar pattern is evident in the non-IWB condition but with a wider range of scores varying form 1.71 (L10) to 3.00, the highest affective engagement rating available. The relationship between Jacob's affective engagement behaviours when the new letters were introduced are displayed in Figure 8-5.

Individual Elements of Affective Engagement

Table 8-7
Jacob: Average Affective Engagement Behaviours per lesson

	Affective Engagement Behaviours - Interest		Affective Engagement Behaviours - Mood		Affective Engagement Behaviours - Persistence	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.71 (0.19)	2.46 - 3.00	2.13 (0.26)	2.00 – 2.82	2.33 (0.38)	1.62 – 2.80
Non-IWB	2.64 (0.38)	1.71 – 3.00	2.18 (0.35)	1.43 – 2.65	2.40 (0.37)	1.71 – 3.00

The means presented in Table 8-7 indicate Jacob was positively engaged across the three elements of affective engagement. In both conditions, Jacob displayed a high level of interest in the lessons, with a slightly higher mean in the IWB condition. Mood and persistence ratings were slightly higher in the non-IWB condition, with greater variability of scores being observed in the non-IWB condition across the three elements.

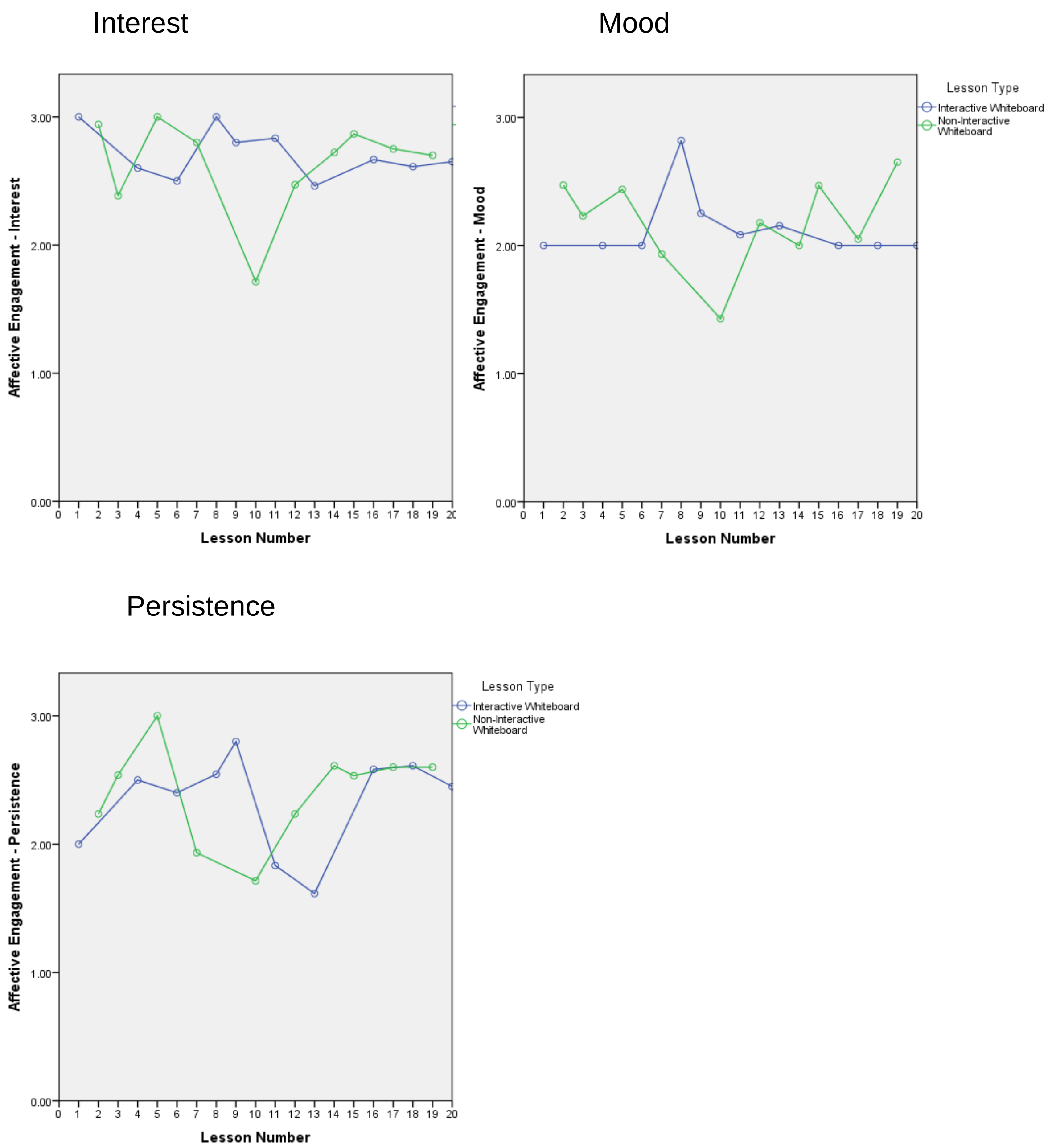


Figure 8-6

Jacob: Average Interest, Mood and Persistence

Interest Scale: 3) shows sustained, intense interest; 2) shows some momentary, intense interest; 1) not upset, but lacks real interest; 0) sad, cries, pouts, angry, frustrated, tantrums. Mood Scale: 3) laughing appropriately, looking to interact with the teacher be part of the group; 2) smiling, looks pleased; 1) bored, expressionless; 0) child not enjoying self. Persistence Scale: 3) independently continued with focus activity, especially when faced with a difficulty/error; 2) attempted to continue on own, but required some assistance to continue with the focus activity; 1) made some effort to complete the focus activity with assistance, no effort when persistence required; 0) no attempt to complete activity when faced with an error/difficulty.

Figure 8-6 illustrates the individual elements of interest, mood and persistence. The interest graph depicts that Jacob showed sustained, intense interest in all but one lesson, lesson 10 in the non-IWB condition, consistent with his task engagement results. The PND results for the interest element were 50%, indicating Jacob showed no preference for either condition.

The mood element in the IWB condition indicated Jacob was relatively stable when involved in these lessons, with the individual lesson scores being a positive mood rating of 2.13 (range 2.00 – 2.82). Lesson 8 was the high point, the first lesson he encountered the Reading Doctor™ program and the second lesson of working with the letter sounds /s/ and /t/. His mood fluctuated more in the non-IWB condition, still averaging a positive rating of 2.18 (range 1.43 – 2.65). The PND score was 70%, moderately in favour of the non-IWB condition.

The element of persistence showed variability in both conditions, although the means were very similar at 2.33 (range of 1.62 – 2.80) in the IWB condition and 2.40 (range 1.71 – 3.00) in the non-IWB condition. Lessons 11 and 13 were the low points for persistence in the IWB condition. In lesson 11, Jacob had difficulty identifying the beginning sounds of pictures to their matching letter, and his perceived persistence rating dropped, with him requiring assistance to stay with the task. Once the Reading Doctor™ activity commenced, he attempted to independently complete the task set, but required some help. In lesson 13, Jacob spent six of the thirteen recording points changing the colour of the IWB pen or placing his shadow in between the projector and the board. The majority of this lesson was spent consolidating his knowledge of the letter and sound /a/, however, the letters /s/ and /t/ were also included. Lesson 9 was the highest rated IWB lesson for persistence, a lesson in which he worked solidly for the 20 minutes and wanted to continue past the allotted time. Lesson 9 was a lesson in which Jacob had only one letter to concentrate on (/a/), possibly making it easier for him to persist with the task, although this hypothesis is not supported in the non-IWB condition, as the non-IWB lesson in which Jacob was rated as most persistent, was a lesson in which he reviewed an existing letter and a new letter was introduced (L5). The PND analysis indicated a minimal preference for the non-IWB condition (60%).

The randomisation tests were not statistically significant for any of the above elements, with RSS values of 1.61, 1.73 and 2.59 for interest, mood and persistence respectively, all at $\alpha < .05$.

Cognitive engagement

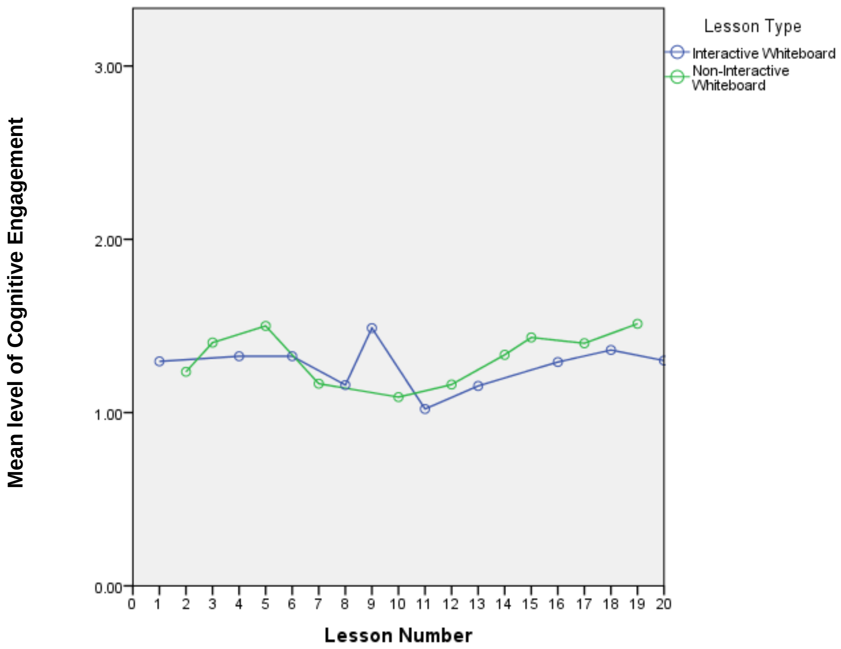


Figure 8-7
Jacob: Mean Level of Cognitive Engagement Per Lesson.
Cognitive engagement: 3) Mostly positive engagement behaviours; 2) Mildly positive engagement behaviours; 1) Mildly negative engagement behaviours; 0) Really negative engagement behaviours

The overall trend for cognitive engagement depicted in Figure 8-7 was flat, with a rating in the mildly negative range for both conditions. As indicated in Table 8-4, the mean cognitive engagement ratings were very similar in the two conditions, as was the range of scores with a mean in the IWB condition of 1.27 (range 1.02 – 1.49) and the non-IWB 1.32 (range 1.09 - 1.51), indicating Jacob had a slight preference for the non-IWB condition.

The PND showed Jacob was more cognitively engaged in 80% of the non-IWB lessons, a moderate effect, supporting the visual analysis. The randomisation test analysis showed no difference between the two conditions with a probability value of a RSS value of 0.37 which does not indicate a statistically significant difference at α < .05.

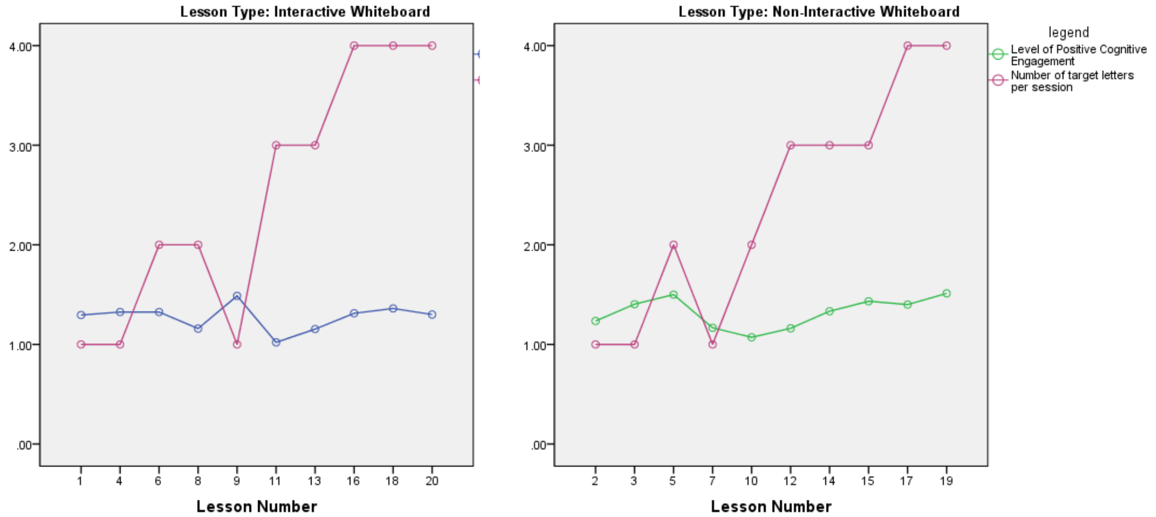


Figure 8-8
Jacob: Cognitive engagement and number of letters per lesson per IWB and non-IWB conditions

The relationship between the number of letters in each lesson and the impact of new letters being introduced is depicted in Figure 8-8. The introduction of new sounds/letters did not have a consistent impact on Jacob's cognitive engagement, with no change being observed with the introduction of the second letter in the IWB condition, and then a negative response on the third introduction and a positive response on the fourth. The non-IWB condition had a positive, then two negative reactions. However, in both conditions, the effect was minimal, as all average scores were in the mildly, negative range. The trend was flat across both conditions, therefore, a cognitive load impact cannot be assumed.

Individual Elements of Cognitive Engagement

Table 8-8
Jacob: Average Cognitive Engagement Behaviours per lesson

	Selection		Elaboration		Monitoring		Problem Solving	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
IWB	2.70 (0.20)	2.45 – 3.00	0.02 (0.06)	0.00 – 0.20	0.09 (0.11)	0.00 – 0.30	2.28 (0.42)	1.33 – 2.85
Non-IWB	2.72 (0.28)	2.14 – 3.00	0.04 (0.10)	0.00 – 0.30	0.13 (0.09)	0.00 – 0.30	2.41 (0.42)	1.60 – 3.00

Table 8-8 presents the means for the four individual elements of cognitive engagement. The element of selection and problem solving indicate that Jacob was able to successfully select the appropriate materials to attempt a task and would then attempt to independently solve the problem in both conditions. The selection means were very similar at 2.70 (2.45 – 3.00) in the IWB condition and 2.72 (2.14 – 3.00) in the non-IWB condition, with more variability in the range of scores in the latter. The problem solving mean was a little higher in the non-IWB condition at 2.41 and a higher range of scores of 1.60 – 3.00 when compared to the IWB condition of 2.28 (range 1.33 – 2.85). The means for elaboration and self-monitoring were in the extremely low range, in both conditions, indicating Jacob rarely connected the sounds or letters to existing knowledge; recognised errors or asked relevant questions to deepen his understanding or connectivity of the letters.

Selection

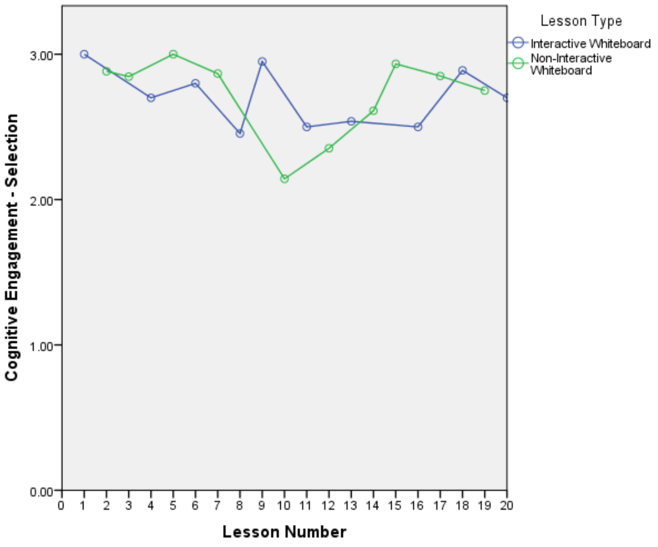


Figure 8-9
Jacob: Average appropriate selection attempts per lesson.
Selection Scale: 3) independently selects correct material to complete the task; 2) selects some or part of the material, but not enough to complete the task; 1) selects material, but inappropriate to the task; 0) no sign of selecting the material.

Jacob was able to independently and successfully select the appropriate materials to attempt the tasks set in both conditions with means at 2.70 for the IWB and 2.72 for the non-IWB lessons. He showed more variability in the non-IWB condition, the evidence of which is depicted in Figure 8-9 and in Table 8-8. There were a number of points of overlapping data, making it difficult to determine a difference between either condition, however, on calculation of the PND, a minimal preference of 60% towards the non-IWB lessons was identified. No statistical significance was found when the randomisation test analysis was performed (RSS = 1.06, $\alpha < .05$). As with the other engagement elements (task and affect), lesson 10 was the lowest point overall, however, Jacob rated in the positive range of scores in this lesson.

Elaboration

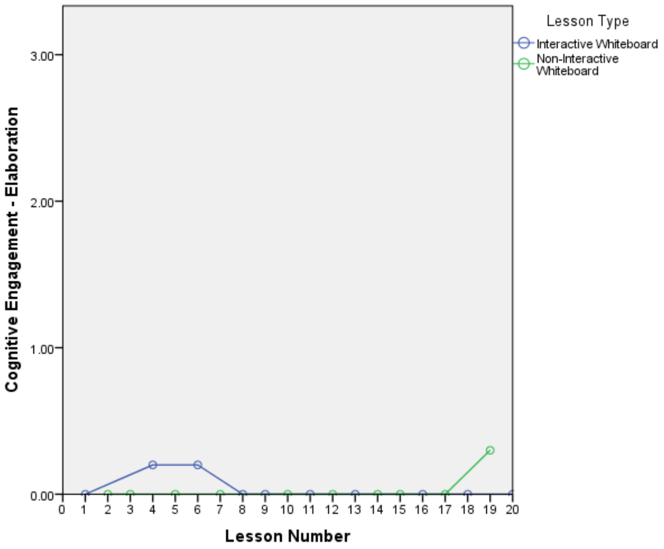
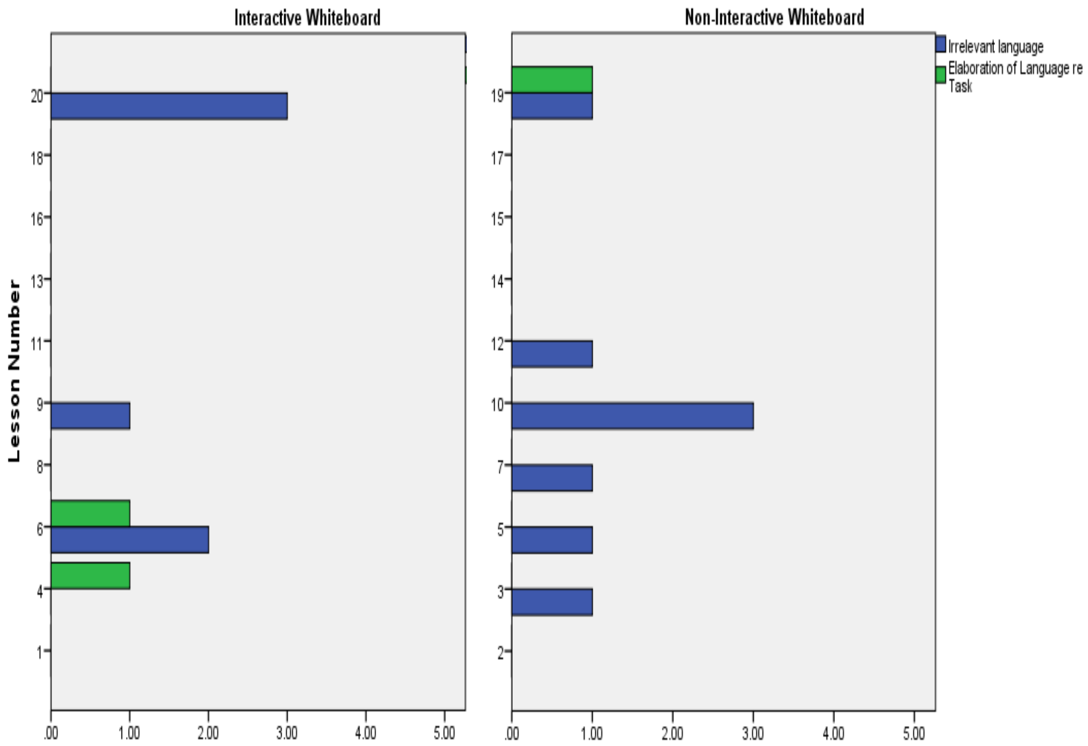


Figure 8-10
Jacob: Average elaborated verbal responses per lesson.
Elaboration Scale: 3: independently connects material with an original elaboration, extends ideas. Can include non-verbal responses; 2: with or without prompting, connects material with previous learning; 1: with or without prompting, attempts to elaborate, but no clear connection with the material; 0: no sign of connecting material to prior learning.

The elaboration element identified responses or behaviours made by Jacob that connected the material presented to anything he already knew. As can be seen in Figure 8-10, elaborated responses were rare, registering on three occasions, indicating he showed very little sign of overtly connecting the material to his existing knowledge. The elaborated responses in the IWB condition recorded Jacob connecting the snakes presented for the letter /s/ with him eating lolly snakes: '*I eat long nakes, lolly nakes' and ' /t/ for telly'* (slang for television)*;* and in the non-IWB condition, Jacob recognised that he had '*done /a/, not them'* (/f/).

Verbal elaborations

Interactive Whiteboard **Non-Interactive Whiteboard**



Number of verbal utterances

Figure 8-11
Jacob: Frequency of irrelevant and elaborated language per condition and lesson
IWB frequency =2 elaborated, 6 irrelevant; non-IWB frequency = 1 elaborated, 8 irrelevant

The verbal responses uttered by Jacob have been further analysed and are presented in Figure 8-11. Jacob was chatty in the lessons, across both conditions, answering questions put to him; however, he rarely extended the conversation beyond a simple response directly connected to the task. He would talk about the task, the letters, or checked whether he had finished or not.

Off task or irrelevant chatter in the IWB lessons occurred when he complained of having tired legs or being tired whilst standing at the IWB in three recorded incidences. In lesson 6 he questioned what the projector was (it illuminated the IWB screen), and in lesson 20 he was distracted by the image on the laptop mirroring the image on the IWB. In the non-IWB condition, he would be concerned about the other students in his class, such as asking what they were doing; would '*Trent* (pseudonym) *doing this too?'*; *'Where are they?'*; talk about his broken finger nail, or his language was indistinct.

The elaboration of language recognised in the lessons and mentioned in the elaboration section was at a low level, occurring twice in the IWB condition and once in the non-IWB condition.

Overall, there was little difference between the conditions in use of language to elaborate upon a theme or idea, or irrelevant language.

Monitoring

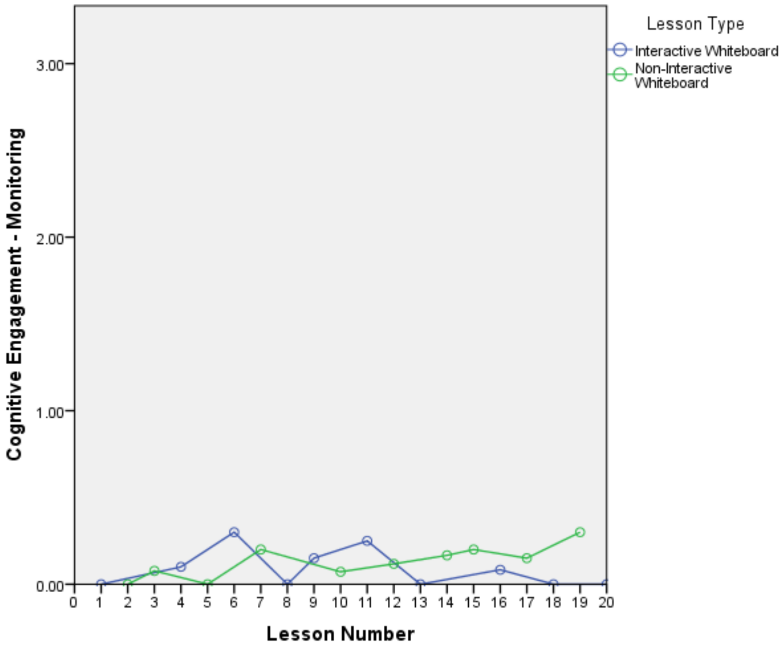


Figure 8-12
Jacob: Average monitoring attempts per lesson.
Monitoring: 3) with no prompting, self-corrects, asks relevant questions; 2) with prompting recognises error, some comments related to error and/or task. No relevant questioning; 1) with prompting, shows some recognition of error, but no clear connection or questions related to task; 0) no sign of self-correction, questioning, recognition of error.

As can be seen in Figure 8-12, Jacob self-monitored his responses infrequently. Indeed, on only one occasion was the monitoring recorded as a self-correction which occurred in lesson 4 on the IWB where he said '*Oops, how do I start again?'* All other monitoring responses, whether in the IWB or non-IWB condition involved Jacob asking questions to clarify what was expected of him or for the Reading Doctor™ program to reiterate what had been said as Jacob had not heard the instruction clearly.

The means for the monitoring element indicated little difference between the two conditions (see Table 8-8). The PND analysis indicated a minimal preference towards the non-IWB condition of 55%, however, incidences recorded were so low in this element, that no difference can clearly be made. The RSS value was 0.19 ($\alpha < .05$), a result which indicates no statistical significance between the conditions.

Problem Solving

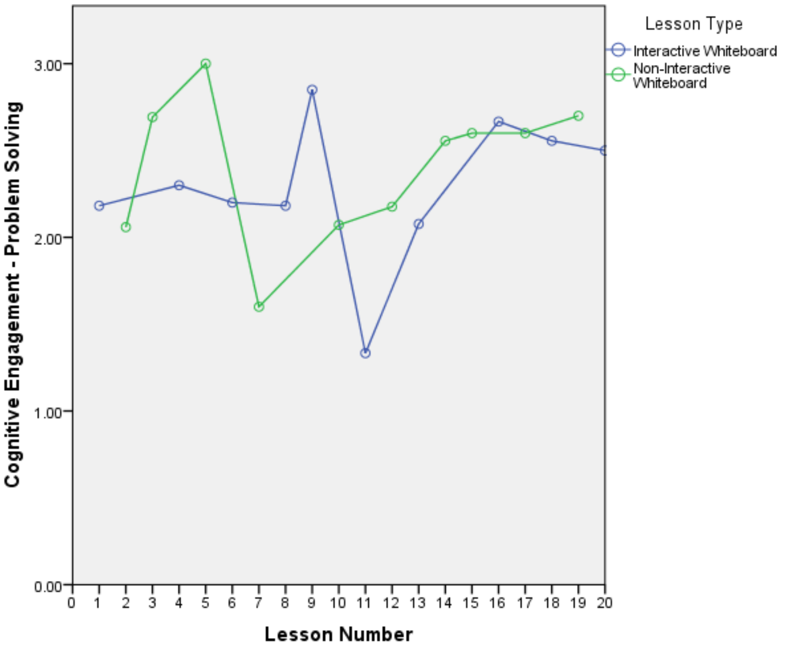


Figure 8-13
Jacob: Average attempts at problem solving per lesson.
Problem Solving: 3) carries out task spontaneously and accurately; 2) attempts on own, partially correct; 1) some progress with much assistance; 0) no progress or not required.

On average, Jacob attempted to problem solve independently, but required some assistance to complete the task accurately. In the IWB condition, he scored a mean of 2.28 (range of 1.33 – 2.85) compared to the non-IWB condition mean of 2.41 (range 1.60 – 3.00). Jacob's attempts at problem solving fluctuated across the lessons, as is depicted in Figure 8-13, and displayed in Table 8-8. The PND analysis indicated Jacob was more able to independently problem solve in 60% of the non-IWB lessons, a minimal effect. The randomisation test analysis value of RSS at 3.13, was not significant.

The skills Jacob used to assist in problem solving across both conditions involved him asking for clarification of the tasks set, guessing by drawing on the information provided in pictures, relying on a combination of verbal and pictorial prompts, and imitating the actions of the researcher. Jacob was particularly reliant on simultaneous provision of both of the verbal and pictorial/written prompts, struggling on every occasion when only one was provided. He was also stronger at responding non-verbally, being more successful, again in both conditions when he was able to point to, or write, an answer.

Jacob appeared to rely upon his memory to recall letter sounds when presented with a written letter, needing to be directed by the researcher to '*look at the letter'*. In the non-IWB lessons, Jacob was directed to look at the letter presented in the task before attempting to answer in the first eight of the ten lessons. In the final two lessons, Jacob was looking very intently at the tasks while they were being introduced to him. Previously when a new task was introduced, Jacob would fidget, by playing with pencils on the table, drop things and 'dive' beneath the table to retrieve them. There were no incidents of re-direction to task that were coded in the IWB condition. However, there were incidents of avoidance behaviour such as changing the colour of the pen, using the built-in eraser, playing with the pictures on the board, placing his body between the projector and the board to cast a shadow and block the images from appearing, and complaining of '*tired legs'* when he was unsure of an answer or tasks were more difficult in eight of the ten IWB lessons. These behaviours were particularly evident when a new, unfamiliar task was introduced to Jacob.

Cognitive Load

Table 8-9
Jacob: Number of letters per lesson and the introduction of new letters

Lesson No.	1	2	3	4	5	6	7	8	9	10
IWB	NL		NL			NL		NL		
sequence	(L1)	(L4)	(L6)	(L8)	(L9)	(L11)	(L13)	(L16)	(L18)	(L20)
No. sounds	1	1	2	2	1	3	3	4	4	4
Non-IWB	NL		NL		NL				NL	
sequence	(L2)	(L3)	(L5)	(L7)	(L10)	(L12)	(L14)	(L15)	(L17)	(L19)
No. sounds	1	1	2	1	2	3	3	3	4	4

NL = New letter introduced.

Jacob was introduced to four letters in both conditions. Table 8-9 depicts when the letters were introduced and the number of letters presented to Jacob each lesson. The number of letters Jacob was exposed to was related to his performance during the previous lesson, or at the discretion of the researcher to enable words to be created with the letters presented, attempting to create a relevant link between the individual letters and words Jacob encountered in his class readers and other classroom work. The need to form words with the target letters was based upon the synthetic phonic approach of learning the letter-sound correspondence and then attempting to apply this knowledge of letters to reading, providing a rationale for the learning.

The management of cognitive load was attempted through using the commonly occurring letters Jacob encountered in his readers and work with the speech pathologist and repeating tasks to build familiarity.

Table 8-10
Jacob: Pearson's correlation comparing the relationships between the number of letters presented and task, affective and cognitive engagement scores

	Task Engagement	Affective Engagement	Cognitive Engagement
IWB n=10	-.360	-.256	-.239
Non-IWB n=10	-.007	.311	.406

The Pearson's correlation between the number of letters and the engagement constructs showed no significant relationships in either condition (see Table 8-10). The results in the IWB condition were in the weak, negative range, indicating as the number of letters increased a weak decline in engagement behaviours was recorded. In the non-IWB condition, there was no relationship between the number of letters and task engagement, and non-significant moderate, positive relationships between the number of letters and affective and cognitive engagement behaviours.

The figures that depict the three engagement constructs and number of letters presented did not show a consistent pattern of change when a new letter/sound was introduced or an increase in the number of letters/sounds presented in a lesson. However, on closer inspection of individual lessons, it became apparent Jacob's ratings of persistence (Figure 8-6) and problem solving (Figure 8-13) would fall to negative levels when he was faced with more than one letter/sound at the same time, as opposed to a variety of individual letters/sounds at a time. For example, three letters may be presented during a lesson, and if presented individually, his engagement levels would remain positive. However, if the letters were presented simultaneously, his ability to persist and problem solve would fall, indicating Jacob was becoming overloaded. In these instances he would resort to on-task questioning such as '*What next?' 'What do I need to do?'* It appeared that these questions were not used to further his understanding of the task presented, but were more of a way of reducing the possibility of making an error and to have the researcher provide more information to assist in the completion of the task – a task that with only one letter/sound presented he was able to complete independently and successfully. This strategy may be a more useful strategy than that used by Martin, who would talk of irrelevant things when the lessons were perceived to be too hard, such as who should or should not use sharp scissors. Jacob, however, appeared to process the additional information only superficially, as it was not evident that he would use the new information to assist in future tasks where two or more letters/sounds were again presented.

Letter acquisition

Jacob was introduced to four letters in each condition. In the IWB condition, Jacob was introduced to the third letter a lesson later than the non-IWB condition, but the fourth letter was intruded a letter earlier. Similar to Martin, Jacob struggled when the letters were presented at the same time in a lesson, having trouble mapping the different sounds and letters against each grapheme presented.

Summary: Jacob

Table 8-11
Jacob: Summary of engagement behaviours

Type of Engagement Behaviours	Individual Engagement Elements	Visual Analysis	PND Effect	Randomisation Test	Summary
Task engagement		no visual difference	minimal IWB > non-IWB	no significance	no difference
	Activity related	no visual difference	minimal IWB > non-IWB	no significance	no difference
	Eye contact	no visual difference	no relationship	no significance	no difference
Affective engagement		non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB
	Interest	no visual difference	no relationship	no significance	no difference
	Mood	non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB
	Persistence	no visual difference	minimal non-IWB > IWB	no significance	no difference
Cognitive engagement		non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB
	Selection	no visual difference	minimal non-IWB > IWB	no significance	no difference
	Elaboration	no visual difference	no relationship	no significance	no difference
	Monitoring	non-IWB > IWB	no relationship	no significance	no difference
	Problem solving	no visual difference	minimal non-IWB > IWB	no significance	no difference

The rule used to determine whether a difference between the two conditions was evident was where all three analyses were in the same direction in favour on one condition, a consistent difference was assumed; a favourable difference existed when two of three analyses were in the same direction; and no difference existed when one or none of the results were in favour of a condition.

Jacob showed growth in his grapho-phonic knowledge over the twenty lessons. On pre-test, Jacob was only able to identify the letter /s/ when presented verbally, and no letters when presented in print. On post-test, Jacob successfully identified 75% of the letters taught when presented to him verbally and 62.5% of the letters taught when presented in print format.

Jacob showed high levels of task engagement in both conditions indicating he was able to visually connect with either the task or the researcher and engage positively with the task. The results (Table 8-11) indicate that neither condition was more engaging than the other.

The individual scores for affective engagement showed more variance, while still scoring in the positive rating range. The engagement summary for overall affective engagement (Table 8-11) shows there was a preference towards the non-IWB condition, however no difference between the two individual elements of interest or persistence, and with two of the three tests, a preference towards the non-IWB condition for the mood element.

For cognitive engagement, the scores averaged in the low negative, but indicated that he could select the appropriate materials to attempt a task, and would attempt to complete tasks independently, requiring some guidance to be successful. The near non-existent levels of elaboration and monitoring indicate Jacob would be limited in the transformation of the new knowledge to his existing knowledge.

The majority of language spoken by Jacob during the lessons was task related, or concerned with what his classmates were doing – *'is Trent doing this?; Where is my class going?* He was quite reluctant to attempt tasks independently without checking what was next or how the task was to be completed. A change from what occurred two terms later when his teacher commented on his continued improvement, stating:

> *Jacob now knows nearly all his letters well and wants to learn letter combinations. With support, he is beginning to be able to*

blend, and he finds it much easier to learn sight words. He is using a personal dictionary to write short stereotypic sentences quite independently WOW!

9. RESULTS SUMMARY

The Participants

The five participants were selected from two junior primary special class settings from two schools situated south of Adelaide, South Australia. All students had been identified as having Global Developmental Delay and severe language delay. Each student participated in twenty individual lessons, ten IWB and ten non-IWB based on their individual reading needs. Four of the five students were exposed to sounding and blending cvc words, while the fifth undertook lessons in letter/sound correspondence. All lessons were conducted in the morning.

Research Questions

The overarching question for this thesis is: What impact do interactive whiteboards, used as a teaching tool, have on dimensions of engagement and on performance in reading of students with intellectual disability, when compared with parallel lessons taught without the use of an interactive whiteboard? More specifically, can the use of IWBs increase the level of task engagement behaviour, affective engagement behaviour and cognitive engagement behaviour in the learning process beyond the levels observed in the non-IWB condition? And do those on-task behaviours lead to reading (phonological awareness) skills being acquired at a faster rate in the IWB condition as compared to lessons taught without the use of IWBs?

Intervention

The intervention activities were designed so that for the most part, they were experienced in both conditions, therefore, limiting the differences in conditions to the letters or rimes taught. Table 9-1 summarises the letters, rimes and activities used in the IWB and non-IWB conditions.

The researcher's teaching approach towards the lessons was analysed by a third party to ensure no bias was displayed towards either of the conditions.

Table 9-1

Summary: Letters used and activities undertaken in the IWB and non-IWB conditions

Sounding & Blending	**IWB: s a t b u g m r**	**Non-IWB: p i n l e d f r**
onset-rime families	✓ **at ag ug**	✓ **in ip ed**
picture-word matching	✓	✓
cloze exercises	✓	✓
rebus exercises	✓	✓
memory game	✓	✓
word recognition games one rime, multiple rimes	Reading Doctor™; Starfall 'learn to read' phonics internet game	fish; snakes n ladders; Go Fish card game; bingo
word building	drag n drop	magnets
say, trace, write	✓	✓
stories	✓	✓
identify onset, write	✓	✓
rime and picture provided, i.e. find the onset to make the word /mat/	✓ interactive website	✓
Researcher said word, student wrote	✓	✓
identify rime/rhyme	✓	
illustrate a sentence		✓
Grapho-phoneme	**IWB: s a t g**	**non-IWB: p i n f**
picture-letter identification	✓	✓
say, trace, write	✓	✓
letter recognition games	Reading Doctor™	fish; snakes n ladders; Go Fish card game; bingo
memory game	✓	✓
play dough		✓

Pre and Post-test Results

Table 9-2
Summary: Participants pre and post-test results in sounding and blending

Word	Jonathon		Martin		Kris		Corrine	
presented	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**
vc	**50%**	**100%**	**100%**	**75%**	**75%**	**100%**	**0%**	**75%**
an	x	✓	✓	✓	x	✓	x	at
on	✓	✓	✓	✓	✓	✓	x	✓
it	✓	✓	✓	if	✓	✓	x	✓
is	x	✓	✓	✓	✓	✓		✓
cvc	**0%**	**100%**	**10%**	**50%**	**0%**	**50%**	**0%**	**60%**
ran	x	✓	✓	✓	x	✓		nit
bed	x	✓	x	sounded d/e/d said /dad/	x	**fin**/**dip**		**dip**
mop	x	✓	x	mog	x	✓		✓
bin		✓	x	✓		**dip**/dig		✓
leg		✓		**led**		✓		✓
pat		✓		✓		pit		✓
dog		✓		✓		**dip**		✓
sad		✓		✓		✓		stop
pig		✓		**pin**		✓		✓
fan		✓		**fin**		**fin**		fun/**fin**

* Highlighted word was a word taught during the lessons

As can be seen in Table 9-2 the four participants involved in the sounding and blending intervention learned how to decode some of the words that were presented in the post-test, indicating that some learning in this strategy had occurred over the twenty lessons. Jonathon and Martin both used the strategy independently, whereas Kris and Corrine required reminding in the post-test to use the sounding and blending strategy. The change across time was steady rather than being dramatic and was somewhat stronger for the cvc words.

Jonathon successfully read the ten cvc words presented. Martin read 50% of the presented cvc words in the post-test. However, it appeared he was still reliant on direct retrieval of words rather than to actively use the sounds he heard to then blend into the words presented. Part of Martin's intervention was to focus on directionality of print. Initially he started at any letter in a word, however, after the initial two lessons, this was not of concern. More importantly for Martin was the need to get him to look at all the letters in the word presented, as he would generally rely upon the first letter and then attempt to recall known words that started with that sound. He also required a focus on differentiating between b/d/p, and after lesson 8, his confusion was less pronounced, indicating he had made some progress. In the post-test, he showed one instance of b/d confusion with the word /bed/; sounding it as d/e/d/ and blending it as /dad/. His other incorrect responses had the initial sound correct and then he offered an alternative word that started with that sound.

Kris on pre-test, did not show signs of b/d confusion, however on his post-test results the two words beginning with /b/ have been misread as /d/, although it would appear his responses were drawn from direct retrieval rather than from sounding and blending the onset-rime presented. For example, the responses for /bed/ were /fin/ and /dip/ both words from the intervention, and the word /bin/ led to /dip/ and /dig/ being offered. Again, /dip/ was a target word from the intervention. When reminded to sound and blend the test words, Kris was successful in reading five of the ten cvc words. Kris also independently read unknown cvc words in lessons 17, 19 and 20 when playing Snakes and Ladders in the non-IWB condition and on the Reading Doctor™, indicating he could apply the skill being taught to other applications and situations.

Corrine on pre-test would ‘read’ words according to the dominant sound or letter she recognised, responding with ‘apple’ for /an/ and ‘Thomas’ for /it/. On post-test, and with prompting, she was able to sound and blend six of the ten cvc words presented. She continued to show some confusion with the dominant sounds and relied on direct retrieval to recall words.

Table 9-3
Summary: Jacob's pre and post-test results; verbal and print presentations

Letter presented	Verbal Presentation Pre-test	Verbal Presentation Post-test	Print Presentation Pre-test	Print Presentation Post-test
	12.5%	56.25%	0%	50.0%
a**	**e**	✓	**m**	✓
b	p	o	m	p
c	g	✓	d	t
d	f	r	1	p
e	c	c	the	c
f**	**s**	**d**	**-**	**t**
g**	**a**	✓	**m**	**m**
i**	**o**	✓	**8**	✓
l	✓	-	r	✓
m	e	✓	the	✓
n**	**a**	✓	**b**	**p**
o	n	n	m	✓
p**	**l**	**f**	**m**	✓
r	b	✓	a	d
s**	✓	✓	**8**	✓
t**	**c**	✓	**1**	✓

Verbal = 2:16 to 9:16; Print 0:16 to 8:16

Jacob's pre and post-test results presented in Table 9-3, show growth over the twenty sessions. He went from being able to hear and then identify in print two sounds to identifying nine sounds (verbal presentation), and in the print presentation to being unable to identify any letters to identifying eight letters. Six of the eight verbal and five of the eight print letters were letters and sounds targeted during the lessons (presented in bold).

Engagement Results

The tables that follow summarise each student's engagement behaviour measures for task, affective and cognitive engagement. The tables show whether there was a preference for either condition when analysing the data visually, through PND or by using randomisation test analysis. The mean range reported indicates where the student's mean engagement score was on the SERS; whether the behaviours observed were in the mostly positive range, mildly positive range, mildly negative range or really negative range.

To determine whether or not the students displayed a preference towards a teaching medium, IWB or non-IWB, the rules used were:

1. to determine whether a difference between the two conditions was evident was where all three analyses were in the same direction in favour of one condition, a consistent difference was assumed;
2. a favourable difference existed when two of three analyses were in the same direction, favouring one condition; and
3. no difference existed when one or none of the results were in favour of a condition.

Task engagement

Task engagement behaviours were those behaviours observed relating to the students **eye contact** with either the researcher or the task, and **activity related** behaviour.

Table 9-4
Summary: Task engagement behaviour measures^

	Means, range of scores	Visual analysis	PND effect	Randomisation test	Summary
Jonathon	mostly positive	IWB > non-IWB	moderate IWB > non-IWB	no significance	in favour of the IWB
Martin	mildly positive	non-IWB > IWB	minimal non-IWB > IWB	no significance	in favour of the non-IWB
Kris	mostly positive	no visual difference	minimal IWB > non-IWB	no significance	no difference
Corrine^	mostly positive	no visual difference	moderate IWB > non-IWB	no significance	no difference
Jacob	mostly positive	no visual difference	minimal IWB > non-IWB	no significance	no difference

^ Removal of the outlier lesson, lesson 17.

As shown in Table 9-4, four of the five the students scored in the mostly, positively task engaged range during the IWB lessons. These scores averaged between 2.51 and 2.83. Although, the non-IWB average task engagement figures were lower, the five students all scored above 2, indicating they were mildly to mostly positively task engaged in this condition. On visual inspection, a slight preference for the IWB lessons was shown by Jonathon, Martin displayed a preference towards the non-IWB lessons, and the remaining three students showed no preference. The PND analysis indicated a minimal to moderate preference towards the IWB condition by four of the students, while one indicated a minimal preference towards the non-IWB. The randomisation test analysis resulted in no significant results towards either condition. Overall, no difference can be found between the two conditions on this measure of task engagement.

Affective Engagement

Affective engagement behaviours were those observable behaviours of **interest** displayed towards the lesson, general **mood** of the student toward a task and **persistence** towards a task.

The range of the mean scores for affective engagement behaviour presented in Table 9-5 indicate that four of the five students were mildly, positively engaged in both conditions, while one scored in the mostly positive range. Upon visual inspection of the data, three of the five students indicated no preference towards either condition, while two students showed a preference for the non-IWB. The PND analysis indicated three students had a preference towards the non-IWB condition, and two showed there was no relationship. The randomisation test analysis indicated one significant effect towards the non-IWB condition.

Table 9-5
Summary: Affective engagement behaviour measures^

	Means, range of scores	Visual Analysis	PND effect	Randomisation Test	Summary
Jonathon	mostly positive	no visual difference	minimal non-IWB > IWB	no significance	no difference
Martin	mildly positive non-IWB > IWB	non-IWB > IWB	moderate non-IWB > IWB	significant non-IWB > IWB	moderate, significant effect non-IWB > IWB
Kris	mildly positive IWB > non-IWB	no visual difference	no relationship	no significance	no difference
Corrine^	mildly positive	no visual difference	no relationship	no significance	no difference
Jacob	mildly positive	non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB

^ Removal of the outlier lesson, lesson 17.

There was no consistent pattern of greater affective engagement in one condition for all five students. Instead there was a moderately significant effect towards the non-IWB in one of the cases, a favourable result towards the non-IWB in another, whilst the remaining three showed no differences in affective engagement in the two conditions. The lack of a strong preference, and the positive range of scores obtained by the students, indicate that students were generally happy to attend all the sessions, showed interest in the tasks presented and showed some persistence when faced with task difficulty. Any trend lines that appeared in the engagement levels were very slight. Results for Corrine and Kris displayed a slight negative trend in both conditions, those for Jonathon and Jacob indicated no trend across the lessons, and for Martin showed a slight negative trend in the IWB condition, whilst no trend in the non-IWB condition.

Cognitive Engagement

Cognitive engagement behaviour were those behaviours observed in relation to four elements: the appropriateness of the ***selection*** of materials; the relating to, or transformation of, information *(**elaboration**)*; the self-***monitoring*** of actions in relation to asking relevant questions or correcting mistakes; and attempts at ***problem solving***, whether independently and spontaneously or with vary amounts of assistance.

As Table 9-6 indicates the students' cognitive engagement behaviours averaged in the really negative to mildly negative range of scores, showing they did not show evidence of frequent use of the broad skills of selecting, elaborating, monitoring or problem solving. Consideration of the individual elements of cognitive engagement showed that the students as a group displayed very varied levels of engagement across the four elements. The PND comparisons indicate there was no preference towards a condition, by three of the students, while two indicated a moderate preference towards the non-IWB condition. The randomisation tests resulted in one statistically significant result in favour of the non-IWB condition.

Table 9-6
Summary: Cognitive engagement behaviour measures^

	Means, range of scores	Visual analysis	PND effect	Randomisation test	Summary
Jonathon	mildly negative	no visual difference	no relationship	no significance	no difference
Martin	really negative	non-IWB > IWB	moderate non-IWB > IWB	statistical significance non-IWB > IWB	moderate, significant effect non-IWB > IWB
Kris	mildly negative	no visual difference	no relationship	no significance	no difference
Corrine^	mildly negative	no visual difference	no relationship	no significance	no difference
Jacob	mildly negative	non-IWB > IWB	moderate non-IWB > IWB	no significance	in favour of the non-IWB

^ Removal of the outlier lesson, lesson 17.

Selection

Generally, the students rated in the positive range of scores for selection, indicating that they could independently select the appropriate materials to complete a task. Martin scored lowest in this element, rating in the mildly negative to mildly positive range of scores, indicating he needed assistance to correctly select the materials required to complete a task. Jonathon and Jacob indicated no preference towards a condition, Kris selected more independently in the IWB condition while Martin and Corrine were more successful at correctly selecting appropriate materials in the non-IWB condition.

Statistically, only Martin rated a minimal, significant effect towards the non-IWB condition.

Elaboration

The volume of elaborations, whether verbal or non-verbal was very low, scoring in the really negative range. As indicated in the individual results, all students, regardless of condition, rarely attempted to connect the target word or letter to prior learning. Statistically, both Jonathon and Martin scored a minimal, significant effect in the non-IWB condition, the results for the other three students showed no difference between the two conditions.

The types of elaborations used in the non-IWB condition by the students to indicate their understanding of a word were to put the word in a sentence or tell a story related to the word, there were some attempts to write words in sentences or attempts to make words out of the magnets or cards or to alter the position of the magnets or cards to correct or create a word.

In the IWB condition, two students changed the words in the target sentence to reflect their use of the word, and more often, the target word would be connected to another word to convey or ensure understanding of the word.

Verbal Responses

Language use varied amongst students as the number of rimes they were exposed to increased. Some used language as an avoidance tactic (irrelevant language), while others stayed on task, only responding to the questions put to them or the sounding out of the words placed before them. Irrelevant language was language used which bore no connection to the task at hand. Martin, in particular, would attempt to engage the researcher in non-task related conversations in an endeavour to avoid the task, thus indicating a lack of cognitive engagement in the lesson.

There was a very clear difference between the two conditions in the production of language in the four students learning the strategy of sounding and blending. The level of elaborated responses in the non-IWB condition was nearly double those produced in the IWB condition; an important observation and outcome as all the students had severe language delay, and required extensive practice at communicating to convey or gain understanding of the world around them.

The difference in the production of elaborated language in the non-IWB condition may have been due to students being less mobile and the researcher having a greater physical presence, as they were seated at a desk with the researcher immediately next to them. It may be that the sheer size of the IWB and its control functions acted to depress the level of elaborative language The students had to move around a lot more to focus on the screen, and if feeling unable to complete an activity, could then resort to physically removing the problem by scribbling, deleting or shutting it down. The non-IWB activities, whilst still performing the same function as those on the IWB, were less disposable, and this, possibly, led the students to engage more verbally with the tasks at hand.

Irrelevant language production was very similar across the conditions for Martin, Kris and Jacob. Jonathon scored zero irrelevant language and Corrine's irrelevant language was more than double in the non-IWB condition, primarily due to her singing and whistling on many occasions during those lessons.

Monitoring

The students were very poor at monitoring their responses to questions put to them, rarely checking their answers for accuracy. The Reading Doctor™ program on the IWB performed much of the monitoring for the students, such as providing picture prompts if they took too long to select an answer on the board, and the answers would reset if an incorrect attempt was made by the student. Much of the monitoring that went on in this condition was the student pressing the icons to have the word or letters said back to them by the Reading Doctor™ program. The flipcharts also provided a form of monitoring for the student by having incorrect answers go behind the layers built into the flipchart and effectively 'disappear' when dragged onto the answer area. Monitoring in the non-IWB condition needed to be generated by the student as there was no program to do it automatically for them. In both conditions there was very little evidence of monitoring. However on the rare occasions it did occur: Corrine, Kris and Jonathon would use the context of a sentence to aid their understanding of a word, and if the initial response did not make sense, they would then change the target word. Jonathon, Jacob and Kris would use questioning if they did not understand something, and Corrine was able to visually recognise when letters were written or placed incorrectly.

Martin showed the least amount of self-monitoring, generally because he was adversely affected by his error making, resulting in him employing avoidance behaviours and making no attempt to check his answers.

Problem solving

The problem solving element rated the students' attempts to complete tasks within the sessions independently and accurately, or whether they required some or much assistance to do this. On comparison of the three forms of analysis, two students scored in the favourably effective range in preference towards the IWB, one a minimal yet significant effect towards the non-IWB, while two showed no difference between the two conditions.

Table 9-7
Summary: Problem solving skills observed

	Jonathon	Martin	Kris	Corrine	Jacob
Both IWB and non-IWB					
ask questions			✓		✓
guess by using picture clues	✓	✓	✓	✓	✓
rely on verbal AND pictorial prompts			✓	✓	✓
look at mouth as words/sounds were said	✓	✓	✓		✓
sound out independently	✓		✓		NA
use initial/final letter/sound to recall known words	✓		✓	✓	NA
wait for prompts/redirection from Researcher or IWB program		✓		✓	✓
use context of the sentence	✓		✓	✓	NA
IWB only					
press letters on RD™ (voice response)	✓	✓	✓	✓	✓
use disappearing icons	✓		✓	✓	✓
check previous screens for correct spelling	✓				NA

NA – not applicable

The observable problem solving skills the students utilised were very similar across the conditions and between students. Table 9-7 presents the types of skills the students used, indicating they may not have possessed the skills or strategies required to become more independent learners.

Martin used the least number of observable problem solving strategies, instead engaging in avoidance behaviours when he perceived or experienced a problem. Corrine would also engage in avoidance tactics however her trigger was the perception of a task being too difficult.

Jonathon learned to use the sounding and blending skill independently, with him making the comment that he was also using sounding and blending in the classroom: He scored 100% and sounded and blended the ten cvc words without being prompted. His teacher also commented that he was attempting to decode more words in the classroom, indicating a good transference of the skill taught. Kris and Corrine experienced success in the post-test once they were reminded to use the sounding and blending skill (50% and 60% accuracy respectively). However, their primary response was to use direct retrieval to recall known words rather than use the skill being taught. The identification of students utilising skills or strategies taught is important as it indicates they can successfully select, organise and integrate information presented to them. The goal is then to have the students independently apply these skills in novel situations across the curriculum.

Table 9-8 shows the incorrect responses provided by Kris, Martin and Corrine, the words in bold were words taught across the lessons.

Table 9-8
Summary: Incorrect responses on Post-test

Word presented	Kris	Martin	Corrine	Letter presented verbal/print	Jacob verbal/print
ran			nit	b	o/**p**
bed	**fin / dip**	dad	**dip**	c	✓/t
mop		mog		d	r/**p**
bin	**dip** / dig			e	c/c
leg		**led**		**f**	**d**/t
pat	pit			**g**	✓/m
dog	**dip**			l	-/✓
sad			stop	**n**	✓/**p**
pig		**pin**		o	**n**/✓
fan	**fin**	**fin**	fun/**fin**	**p**	**f**/✓
				r	✓/**d**

Jacob's post test results, also in Table 9-8, show he had learned some of the grapho-phonic representations taught. Of those taught in the IWB condition, Jacob successfully identified all the letters upon verbal presentation, and could name three of the four letters when they were presented in print. Of the letters taught in the non-IWB condition, Jacob correctly identified /i/ and /n/ when presented verbally, and /i/ and /p/ when presented in print. When Jacob was asked to identify a letter, he responded with a letter taught in three of the seven incorrect responses, and four out of eight in the print presentation, possibly indicating a recency effect of attempting to apply his new knowledge to what was presented to him without spending the time to think and select first. His lack of monitoring was also evident by the /p/ response to four of the letters, one being correct, without realising he had already responded with that letter.

Cognitive load

Cognitive load was of research interest during the lessons with the students, as the researcher attempted to minimise this by using explicit instruction and building in small, cumulative steps that drew on existing knowledge (Sweller, 2006). For four of the students, their existing knowledge was their alphabetical grapho-phonic knowledge which was then applied to the sounding and blending of cvc words presented in rime families. The fifth student did not have this grapho-phonic knowledge, so was explicitly exposed to a selection of letters that, once learnt, could be blended together to make vc or cvc words.

Overall, the students all experienced some form of cognitive overload when exposed to multiple rimes or letters at a time, particularly when faced with novel tasks and words presented in sentence format. Lesson formats were modified in an attempt to minimise this phenomena and increase engagement and learning. There was also no evidence of one form of lesson delivery being more cognitively overloading than the other.

Rate of Acquisition

Table 9-9
Summary: Introduction of new rimes or letters

Lesson No.	1	2	3	4	5	6	7	8	9	10
IWB										
Student	J				J		J			
	M		M			M				
	K		K		K					
	C		C		C					
	J*		J*			J*		J*		
Non-IWB										
Student	J		J			J				
	M		M		M					
	K			K		K				
	C		C		C					
	J*		J*		J*				J*	

J* introduction of a new letter

All the students receiving instruction in the use of sounding and blending were introduced to three rimes in each condition. Jacob, receiving instruction in grapho-phonemic awareness, was introduced to four grapho-phonemes in each condition. The introduction of the rimes or grapho-phonemes is presented in Table 9-9.

Generally, rimes were not acquired at a faster rate in one condition over the other. In the IWB condition, Martin, Kris and Corrine were all introduced to the first rime during the third lesson. Jonathon took two lessons longer before he was introduced to the second rime but after only two lessons with the second rime, was then exposed to the third. Martin needed a lesson longer with the second rime before the third was introduced, while Kris and Corrine both had two lessons before the third rime was presented.

A similar pattern of rime presentation can be observed in the non-IWB condition in which Jonathon, Martin and Corrine all experience the second rime in lesson three, Kris lesson four, while the second rime was introduced to Martin and Corrine in the fifth lesson and Jonathon and Kris in the sixth.

Jacob was introduced the second letter in lesson three for both conditions, whereas the third and fourth letters were introduced in lesson six and eight in the IWB condition and lessons five and nine in the non-IWB condition.

The lesson number when the final rime or letter was introduced provided an indicator of progress in acquisition of rimes (or letters in Jacob's case). For example, Jonathon was introduced to the final rime in lesson seven in the IWB condition and Martin lesson six. The total progress scores for the two conditions are the same at 31. Therefore, in relation to Research Question 1, there is no strong evidence that the rate of acquisition of reading skills differed between the conditions.

In brief, in regard to the major research questions, the analysis of levels of engagement indicated that there was no consistent pattern of difference between the IWB and non-IWB conditions across the three domains of task, affective and cognitive engagement. The rate of acquisition was similar in the two conditions.

10. DISCUSSION AND CONCLUSION

Introduction

The purpose of this study of early reading was to investigate the effect interactive whiteboards had on the student engagement behaviours of students with intellectual disability when compared to traditional teaching methods.

Five students with Global Developmental Delay, four of whom had severe language delay, participated in the research. Their ages ranged from 6 years 7 months to 8 years 4 months. All students had been at school for at least one full school year (minimum of four terms), and had been placed in a small, regional special class setting. The students ranged in school experience from 5 terms to 13 terms. All had an IWB in their classrooms for at least 4 terms prior to the study.

After a discussion of the findings in relation to each research question this chapter will discuss how the literature, reviewed in Chapter 2, aligns with the findings presented in Chapters 4 to 9. This will be followed by a discussion of the implications of these findings and possible future research in this area.

The research questions

The research questions guiding this study were:

1. Are the reading (grapho-phonic) skills attained at a faster rate in the IWB condition when compared to lessons taught without the use of IWBs?

2. Can the use of IWBs increase the level of task engagement behaviour, affective engagement behaviour and cognitive engagement behaviour in reading tasks when compared to traditional teaching methods?

General Conclusion

Differences in rate of acquisition

The five students did acquire knowledge in the aspect of sounding and blending or letter/sound correspondence using an interactive approach both on and off the IWB. However, neither condition led to a faster rate of acquisition. This finding is similar in pattern to that of Albaaly and Higgins (2012) whereby they found an overall improvement in essay writing with the students due to an intervention, but no difference in outcomes between IWB and the more traditional teaching approach undertaken in essay writing with ESL students in an Egyptian medical school.

Improvement beyond the period of the research was reported for two of the students, as Corrine and Jacob's classroom teacher reported back on how they had continued to progress since the intervention.

Differences in levels of Engagement

With respect to Research Question 2 there was no consistent difference in task, affective or cognitive engagement across the two conditions that was apparent for the five students. Where differences were observed they did not consistently favour one condition.

At an individual level, Martin was consistently more engaged in the non-IWB setting and Jacob also tended to show a higher engagement rating in that setting. Conversely, Jonathon showed a tendency to be more engaged in the lessons with the IWB. Levels of engagement for the other two students showed no consistent differences across conditions for any of the three categories of engagement. Even in this small group of beginning readers, the results suggest that there would be a need for the teacher to make individual decisions about the use of an IWB for reading lessons to optimise engagement.

Levels of different types of engagement

Task engagement

The students were highly, positively task engaged during lessons in both conditions, indicating the tasks were relevant and interesting. Both forms of delivery were effective in keeping the students involved in the lesson tasks and intent on completing them.

Affective Engagement

For the five students, affective engagement was generally in the mildly positive range, indicating that they looked pleased to attend the sessions and showed signs of intense interest in the focus activity. Two of the students' levels of persistence: Martin and Jacob showed a decline when faced with a difficult task, whereas the other three students maintained a mildly positive approach to continuing with problems. Nevertheless, the students did not indicate an overall, strong preference for either condition.

Cognitive Engagement

The overall cognitive engagement ratings were in the negative range for all students. However, there was substantial variation in the observed levels of the individual elements of cognitive engagement. The elements of selection and problem solving were observed more frequently than elaboration and monitoring, the latter two being at very low levels for all students.

Students were rarely observed drawing on the strategy of elaboration that would assist in retaining new knowledge or the incorporation of new knowledge with existing knowledge.

Student talk was an observable form of elaboration and could also have been an indicator of monitoring. Student elaborated talk generated in the non-IWB condition was at a level near double that produced in the IWB condition, indicating greater student elaboration in the lessons away from the IWB.

The monitoring of responses by students was a behaviour seldom observed in either condition.

Language use

All the students produced more relevant language elaborations during the non-IWB condition than when interacting with the IWB. This result has a practical implication for teachers of reading: Teachers want students to make connections between what they are reading and their existing knowledge, because such elaborations and connections have the potential to support increased comprehension and understanding, primary goals of any reading program.

Further to these reading goals, this outcome on elaborated language is significant as many students with intellectual disability also have severe language delay and any attempts at communicating are to be encouraged. The on-task talk, and particularly the talk that involves elaborating and connecting current learning to prior knowledge, helps to embed and build knowledge. This talk also provides opportunities for the teacher to promote further connections to knowledge, providing further opportunities for students to build knowledge. As Alexander (2012, p. 2) stated

"… talk is essential to children's thinking and learning, and to their productive engagement in classroom life, especially in the early and primary years".

There has been a growing focus within the South Australian Education Department of the importance of encouraging student talk in the learning process – the '*Chatter Matters*' Early Years Literacy project (Department of

Education and Children's Services, 2012). This renewed focus reflects international research on oral language development (for example Alexander, 2012; Department for Children Schools and Families; Konza, 2011; Warwick, Mercer, & Kershner, 2013). In this project when students were interacting with the IWB there was very little 'chatter'. Students whose oral language skills are not well developed are less able to use talk strategies for either minor or major problem-solving tasks (Konza, 2011). Through interacting with more literate others, whether it is the teacher, other students or family, students become more actively involved in constructing their understanding of print and language and the connections between the two (Erickson, Koppenhaver, & Yoder, 1994).

Due to more IWBs being installed in classrooms around the world (Warwick et al., 2013) the question '*How to improve students' oral participation when using the IWB?*' becomes increasingly important, particularly for students with speech and language issues. The results of this research project support the research of Warwick, Mercer and Kershner (2013) which focused on explicitly teaching and establishing talk rules to encourage verbal interactions amongst students whilst engaged with the IWB and providing scaffolding to further support this key idea. The students in this project would benefit greatly from an explicit program designed around encouraging greater verbal participation when working with the IWB. Ansell and Foster (2014) further developed this notion in general classroom learning. Alexander (2012) and Rose (2006) specifically mentioned the need to develop and use talk to assist in the development of phonological awareness.

Error making and avoidance behaviour

Students' level of engagement was affected by the making of errors, especially errors made early in the lesson. The pattern of behaviour observed in this study was similar to that reported by Guthrie and Davis (2003) who identified student engagement as fuelled by the self-perception of the ability to perform reading tasks, so that when students perceived they had made an error or the task was too difficult, they would engage in avoidance behaviours in an attempt to distract the teacher from the task. For Corrine and Martin, avoidance behaviours that followed a perceived error or difficult task had a negative effect on learning outcomes and this effect was more apparent in the IWB condition. Newmann, Wehlage and Lamborn (1992) related these avoidance behaviours to the need for competence, so that when the students felt unable to be successful, they would employ strategies to protect themselves from failure. As a consequence, Guthrie and Davis (2003) argued that students in this situation would benefit from specific instruction regarding learning strategies to teach the competency skills required to perform the task. This in turn would help towards building confidence and improved self-perception (Ryan & Deci, 2000) with which they could attempt novel tasks. In the light of such arguments it would seem that students, like those involved in this research, and perhaps students without an intellectual disability and learning difficulties, could benefit from explicit instruction in handling errors. Furthermore, when planning instruction, teachers could take into consideration the skills already known by the student(s) and those required to complete the task to enable strategy instruction to be embedded in the structure of lessons.

General relationships to previous research

Taken as a package, the results in this project are not consistent with much of the existing research on IWBs regarding student engagement, or for students with an intellectual disability.

Results consistent with the research

The results are somewhat consistent with the research that points to the importance of gross motor movement (Learning Development Centre, 2008; Somekh et al., 2007). It is the case that the IWB offers students who are experiencing fine motor difficulties an opportunity to focus on the task content rather than their inability to perform the skills required to complete the motor task.

However, the nature of the IWB also enabled these gross motor movements to be used as a distraction or task avoidance by enabling drawing over the screen. The IWBs used in this research required a stylus (similar to a pen) to manipulate objects/icons on the board so some fine motor skills were still required. This distraction also emerged when the stylus output was changed with regard to colour, size and legibility, and when students deleted pages and or shut down programs if they were attempting to avoid the task rather than endeavouring to complete it.

Results inconsistent with the research

The results of this research project are not consistent with the following claims:

1. **The use of IWBs leads to increased interaction due to multi-sensory aspects** (Lee & Boyle, 2003; Slay et al., 2008; Tanner & Jones, 2007)

As the student engagement data indicated, there was no consistent difference in task, affective or cognitive engagement across the two conditions. The findings here do not support the claim above.

Specifically, increased interaction infers increased discussion between teacher and student. This claim is contested by the results of this research whereby there was reduced student verbal participation in lessons involving the IWBs. The implications of reduced language output were discussed previously in this chapter.

Colour, verbal output and some animations were used in IWB lessons. The use of colour can attract student attention in a manner that black and white photocopied tasks cannot. However, not all desk top lessons were based around using black and white photocopies of pages or lack of use of colour. Rather the non-IWB lessons were designed to imitate whenever possible those offered on the IWB. Such elements included: the use of colour; hands-on activities such as using memory cards to match the electronic memory game of the IWB; and using colourful magnets to 'drag-n-drop' (see Results Summary Chapter for lesson comparison; Table 9-1). It is also relevant to note that some animation in the IWB lessons was found to be distracting, which led to decreased student attention and engagement as the students focused on the animation rather than the target content that was intended to be highlighted in the animation. Verbal instructions and praise and constructive feedback were used in both conditions; the primary difference being the praise received through the Reading Doctor used animations and other sounds to help motivate the student to continue through to the next level.

2. **The use of IWBs enhances student memory** (Smith et al., 2005)**.**

The findings on cognitive engagement are of particular relevance to this claim. As discussed in Chapter 2, the elements of cognitive engagement that were coded in this study could all be seen to have a role in facilitating the establishment of knowledge in memory. The low level of such engagement in both conditions and the lack of consistent differences in frequency of these elements between conditions do not provide support for this claim.

Students were rarely observed drawing connections with their existing knowledge or experiences (elaborating). The results obtained were consistent with those of Tanner and Jones (2007) who indicated that Key Stage 1 students, being students generally aged between 5 – 7 years and the category the students in this research fall into, were not observed using metacognitive strategies to reflect on learning. More recent research with upper primary aged children (11-12 years) on IWB and metacognition has also indicated that lessons on the IWB did not facilitate higher-order thinking, possibly due to the fast pace of the lessons (Whyburn & Way, 2012).

3. **The use of IWBs facilitates multi-channel input (visual, aural and kinaesthetic input) with the use of sound and images to highlight ideas combined with the ability to manipulate of objects** (Bell, 2002; Somekh et al., 2007)**.**

Both conditions incorporated multi-channel input. The difference in point was the IWB required gross motor movements to complete tasks. In both conditions it was found that the students relied heavily on visual and aural prompts from the researcher (non-IWB) or the software program and researcher (IWB). The activities presented to the students were designed to be similar to each other in the sense that both IWB and non-IWB activities would require a tactile, hands-on approach. The Reading Doctor™ software did have aural and visual praise responses built into the program, which were also offered aurally by the researcher on successful completion of tasks in the non-IWB condition.

4. **The use of IWBs is associated with increased motivation and affect** (BECTA, 2003; Gillen et al., 2008; Martin, 2007; Schuck & Kearney, 2007)

The pattern of difference between the conditions on this type of engagement does not support this claim. Indeed the results of some of the five students in this study of early reading behaviour indicated a moderate advantage in affective engagement for the non-IWB lessons.

In research such as that by BECTA (2003), Gillen (2008), Martin, 2007 #144} and Schuck and Kearney (2007) it has been argued that students would stay on task longer, have increased verbal and physical participation in lessons and experience improved self-esteem, enjoyment and motivation when compared with non-IWB lessons. BECTA (2003), Beeland Jnr (2002), Miller et al. (2005), Miller and Glover (2002) and Smith et al. (2005) reported, via self-report measures, that students and teachers found lessons taught on the IWB to be more motivating than those taught using the more traditional methods because they were more enjoyable, more interesting, more engaging and seen to be ‘up-to-date’. This research project focussed on the *observed* behaviour of students in the IWB and non-IWB conditions.

The differences with verbal output have already been discussed, and the engagement ratings of students also indicated no difference in task engagement. The students were highly, positively task engaged in both conditions. The construct of motivation has an affective engagement component and the findings from this research indicated the students did not display more affective behaviours when using the IWB over the non-IWB lessons.

Corrine and Kris were the only two students who asked to use the IWB when exposed to the non-IWB condition. Despite these requests to be on the IWB, the interest engagement levels for both students averaged in the positive range for both the IWB and non-IWB conditions. The research undertaken by Torff and Tirotta (2010) found the claims regarding the motivational effects of the IWB were ‘*not baseless but somewhat overstated’* (p. 379), a claim that is supported by the outcomes of this research.

Overall summary in regards to the general claims

In summary, the findings in this research are not consistent with the broad claims that the use of the IWB is associated with increased levels of student engagement; interaction or enhancing student memory. The multi-channel input advantages are related to the gross motor capabilities rather than the IWB being more multi-channelled; particularly as the intent of the lesson design and implementation was to be as similar as possible in both conditions.

The findings from this research did identify some further issues related to engagement and the use of the IWB. The first of these concerns the very low levels of cognitive engagement evident in either condition, an element of engagement which will require further investigation due to its strong connections with being able to learn new material or skills, and then the transference and generalisation of the knowledge or skills to other situations.

The lower levels of relevant verbal elaborations is another area that requires future research; in the design of both traditional lessons and in IWB software. A challenge for the software designers here is to provide scaffolding that will first prompt students to access relevant existing knowledge and then exploit that accessed knowledge in ways that will strengthen knowledge representations.

A different challenge of how to address the issue of handling of errors arises for all teaching conditions and an investigation into the teaching of specific skills associated with coping with error-making for students with intellectual disability could benefit these students.

The challenges identified in the literature review when using an IWB and their connection to this research project will now be addressed.

Challenges identified in the design of lessons when using IWBs

One of the possible limitations of this research concerns the comparability of the two conditions. Some detail on this was discussed in Chapters 3 and 9 but other challenges were identified in the research literature (Chapter 2).

To reiterate, the challenges such as the fast pace of lessons using IWBs (Tanner & Jones, 2007) and whole class instruction (Somekh et al., 2007) were discounted as the lessons were paced according to the individual student's progress and they were taught on a 1:1 basis. The bewitching capabilities (for example Armstrong et al., 2005; Cogill, 2003; Hodge & Anderson, 2007) of the IWB were diminished in this project as the selection criteria included that students be exposed to an IWB in their classroom for at least 12 months prior to the research commencing. The Reading Doctor™ software program was new to all of the students and may have had some 'bewitching' capabilities, however the Student Engagement Rating Scale results did not indicate any differences in engagement during the program's use when compared to the other IWB activities during the lessons with the exclusion of Jacob's first lesson with the software in which he made verbal comments such as '*Wow'* and jumped up and down with excitement. This overt reaction was not observed in the ensuing lessons that utilised the Reading Doctor™ software.

Byrne and Fielding-Barnsley (1995) and Cutrim Schmid (2008) identified the possibility of presenting too much information at any one time to the students. To overcome this, lessons were designed according to the students' current knowledge, drawing on the work of Ehri et al., (2001a) of teaching only one or two phonological awareness skills at a time, and utilising both visual and aural input processing channels to minimise cognitive load (Sweller, 2006). Martin and Corrine were susceptible to cognitive overload, and so, with the exclusion of final testing in both conditions, Martin was only presented one rime at a time, a change that occurred once lessons had begun. For example, he may have had a pre-test on the previous lessons onset rime words, and if read successfully, a new rime was introduced; or revision may have taken place with the onset-rimes being reintroduced in a lesson to reinforce prior learning. Corrine's lessons alternated between a familiar task and a novel task both of short duration to reduce her sense of overload.

Implications for the teaching of reading to students with Intellectual Disability and lesson design

In many respects this research reinforces the need for teachers of students with intellectual disability to use a variety of interactive, multi-sensory teaching methods that attract the students' attention and keeps them engaged in the learning process. The short, concise lessons worked to keep the students interested and engaged with the lessons.

The findings of this research support the view that lesson planning for these students can be differentiated for individuals, taking into account individual differences in an effort to support and build knowledge, incorporating what the students know and introducing activities to which they are familiar before introducing a novel idea or task. It is important to recognise how the student responds to success and more importantly, to errors. As noted earlier, the student's responses to errors points to the need to prepare students for the possibility of error, explicitly scaffolding the student from what they already know to where the teacher wants their learning to take them. The pattern of Martin's and Corrine's responses points to the need to be mindful of cognitive load, the amount of new information or new tasks students are exposed to in any one lesson. Consideration of these issues would increase the likelihood of students experiencing success early in the lesson to keep them engaged in the learning objectives rather than reverting to avoidance behaviours.

Within the lesson planning phase, attention should be paid to the production of oral language and how the teacher would encourage relevant elaborative talk; whereby the ideas being taught are discussed and integrated with the students' experiences and existing knowledge (Hay, Fielding-Barnsley, & Taylor, 2010). Explicit teaching of cognitive strategies such as goal setting, making a plan, checking on progress, 'thinking aloud' and 'self-talk' (Westwood, 2007) would assist the students in monitoring their understanding of concepts while helping to stimulate relevant elaborations and allow the teacher to monitor the students understanding and progress. The development of these strategies would lead to students becoming more independent in their reading behaviours, which should, in turn, lead to the students being able to offer more opinions, make more predictions and read more independently, thereby increasing their capabilities across the general curriculum.

The importance of explicitly teaching cognitive strategies to younger students, and in particular students with intellectual disability is based on the need to equip students with the ability to eventually self-monitor their responses by applying a learnt strategy to a problem, and ultimately generalising the learnt strategy to other situations, tasks or settings. By explicitly modelling and guiding cognitive strategies, tasks that draw upon student's experiences and interests, cognitive engagement elements such as elaboration and monitoring can be taught to enhance learning, to ultimately help students select, recall, organise and understand the material before them. As noted earlier effective procedures for stimulating greater levels of cognitive engagement is a key area for future research.

The integration of technology into lessons should be with the focus of supporting identified learning goals (Ertmer & Ottenbreit-Leftwich, 2013), guiding the student towards making meaning of the task and constructing personal meaning with the content (Jonassen, 2013), thereby further developing the student's cognitive skills and strategies.

The teacher having sound knowledge in regards to subject content knowledge, pedagogical knowledge and technological knowledge will also help to develop the use of the necessary skills required in learning how to read whilst using appropriate technology or teaching approaches (Belo, McKenney, & Voogt, 2013). A challenge for teachers is to discover which teaching tools or methods are more effective for the variety of students in their classes. A pre-assessment situation could be set up in which student behaviours are observed whilst using the IWB or other delivery method to see which students are more likely to thrive initially and those who will need more scaffolding and support to be successful, particularly with producing language and on-task behaviours.

An unexpected observation during this research was that the non-IWB desktop instruction and tasks were associated with fewer distractions for the student; and students producing significantly more oral language. Therefore, some experimentation with individual students may be required to keep the IWB lessons engaging and with a strong focus on developing relevant, elaborated talk with explicit scaffolding of cognitive strategies that support the learning tasks.

Implications for software development

“*The issue of foremost importance is to develop thinking skills in our students so that they will be able to utilise the power of technological tools to solve problems and do useful work*” (McCain, 2005, p. 84).

McCain’s quote resonates strongly with the results of this research, reminding educators and educational software developers of the need to develop and use technology that helps students develop their metacognitive skills to become problem solvers. Research tells us that high levels of student task, affective and cognitive engagement lead to increased learning opportunities and lead to students becoming successful learners (Fredericks et al., 2003; Fredericks et al., 2004). Therefore, these three engagement domains should be taken into consideration when educational software developers plan and develop their instructional programs. Task and affective engagement are potentially the easiest aspects of engagement that can be built into software; using animations, noises, effects and automatically generated feedback to excite and encourage users. However, for some this can become distracting to the learning task and the underlying learning goal is lost in these bewitching effects. Other distractors, such as count-down timers which require a response before a certain time period and the perceived need to achieve the highest score can also take away from the learning goal, particularly when the students are developing the targeted strategy such as sounding and blending with the cognitive skill required to be successful.

Therefore, software developers also need to put an emphasis on helping the students to develop cognitive skills, an area of skill which was underdeveloped and underutilised by the students in this study, particularly elaboration and self-monitoring of answers before the program generated corrective feedback. Research undertaken by Bippes, Lohuis, Meurs, Smit, Wetterauw, Dekker, et al. (2003 cited in (Kogel, van der Kooy-Hofland, & Bus, 2009) identified students with a low range of executive function skills (self-regulatory skills) had difficulty planning and choosing the correct responses even though the in-built prompts had been activated. The students in this research also had difficulty with this aspect of the program.

Software that explicitly encourages students to link the content of the learning task to their prior knowledge and increase verbal elaborations would be of benefit. Introductory or 'warm-up' sessions could be built into the content that requires students to make familiar connections to content before the focus of the lesson begins. The cueing of student knowledge may help to activate self-monitoring of responses.

The Reading Doctor™ does enable the teacher or practitioner to support learning goals by enabling the specific skill to be targeted, the content to be individualised to represent an appropriate volume of letters, sounds and/or words with built in scaffolds such as picture fading. However, the timer, although ultimately encouraging greater fluency, was a distraction leading to guessing of answers rather than intentional thinking and generation of reasoned responses by the students. As argued with respect to educational games by Kogel, van der Kooy-Hofland and Bus (2009) software needs to provide appropriate feedback which recognises repetition of errors which then provides a reminder of the relevant steps required to be successful with the task (p. 553).

Implications for theory of engagement

This research built upon Fredericks et al.'s (2003; 2004) broad theory of engagement, where student engagement is strongly associated with positive academic outcomes, and consists of behavioural, affective and cognitive components. Due to the students in this research having an intellectual disability and limited language, all aspects of engagement needed to be observable. Therefore, the behavioural engagement discussed by Fredericks and colleagues was interwoven across the task, affective and cognitive domains used in this study, which also drew on the work and scales created by researchers such as Cooper and Brna (2002) Dunlap (1984), Dunlap and Koegel (1980), Furlong and Christenson (2008), Koegel and Egel (1979), Laevers (1994) and Lutz, Guthrie and Davis (2006). The specification of explicit elements of cognitive engagement in this research has extended previous observational analyses of engagement and highlighted the need for allocation of further attention to this dimension.

The Student Engagement Rating Scale (SERS) developed for this research project condensed the components of engagement into concise, observable behaviours which were successfully used with students with limited language and cognitive delay, lending itself to further research with students with an identified intellectual disability and speech and language disorder. The SERS is a reliable tool in assessing engagement behaviours in student with intellectual disabilities and language difficulties.

Fredericks, Blumenfeld and Paris (2004) and Guthrie and Wigfield (2000) raised the question of what types of engagement were observable in younger students? This research has shown that task, affective and cognitive engagement behaviours are observable in students with intellectual disability aged between 6 and 9 years of age.

Future Research

The value of the findings that have emerged from this research points to the need to replicate this research and expand it to other software programs, to students with different disabilities or to whole class settings.

The profile of the students' cognitive engagement suggests that it will be important to examine the effects of the explicit teaching of cognitive learning strategies to students with intellectual disability on learning and cognitive engagement. When reviewing the strategies the students used when attempting to solve problems, (Table 9-7), application of the focus strategy had not become an automated response. Research with more continued and explicit exposure to a particular strategy would be beneficial to see whether students with intellectual disability can transfer the focus skill to other, similar situations.

Encouragement through modelling and guided instruction would lead to the development of oral language. For example, rewarding the use of questioning and the connection and elaboration of ideas would increase vocabulary production and development, and help to build deeper connections with their learning.

Limitations delimitations

As in all research there are important limitations to this research. The project has been exploratory in the direct comparison of the IWB and non-IWB conditions using multiple features of the three components of student engagement. One limitation relates to the researcher's role in the study as both researcher and teacher. A further limitation involved the withdrawal of the students from class to participate in the research. In addition it is important to acknowledge the small number and selection of the students who participated, the limited number of behaviours recorded in the time sampling and the restriction arising from use of a single software program.

The first limitation of this study is found within the role as researcher and teacher. The teaching procedures were kept as similar as possible across both conditions to enable comparisons to be made and conclusions drawn (See Results Summary, Chapter 9). However, students with intellectual disability do not cope well with change, and it was an advantage to have the same person conducting the lessons across both conditions. The potential for researcher bias to affect the students' disposition towards one condition to another is not seen as a major concern in light of the rating of the researcher's behaviour in both conditions. An independent rater viewed a random selection of video footage across both the IWB and non-IWB lessons and a range of students and no bias was evident.

The second limitation relates to the size of the sample, with five single-case studies being conducted. The small number of students who participated in the research affects the generalisability of the findings to larger populations. However, the alternating treatments design had in-built features that helped to minimise many of the threats to internal validity, such as having two distinct treatment conditions to enable the students to clearly identify which treatment condition they were encountering, the randomisation of lessons to avoid the student anticipating the condition about to be encountered (Barlow & Hersen, 1984). The recommended minimum of at least four phases (sessions) and five data points for each phase was also exceeded, with each condition having at least ten data points per session and each condition had ten phases or sessions, enabling a pattern and trend of responding to be observed (Kratochwill et al., 2013). The ATD approach is best used with teaching behaviours that cannot be reversed, as was the case in this research (Sindelar et al., 1985). The students who participated in the research were not randomly selected from a population of students; rather, they were selected due to the nature of their disability and their reading ability.

Finally, the approach taken with the recording of observed behaviours was to record the ‘most engaged behaviour’ within each time period. This may have led to the over estimation of task, affective or cognitive engagement behaviours being observed and reported. However, this approach was common to both conditions, and as discussed by Meany-Daboul, Roscoe, Bourret and Ahearn (2007), the recommended discontinuous measurement method for estimating the frequency of responses is Partial Interval Recording, as was undertaken in this study.

It is clear that the findings here are limited in application to one software program. However, the program is one that is designed specifically for the reading tasks used in the research and as discussed in several sections above it does have characteristics that are employed in many programs used with the IWB.

The conclusions being drawn here are not about all past or future IWB lessons on reading. They must be interpreted within the framework of this study and these limitations provide directions and possibilities for future research which will continue to add knowledge to the field of student engagement, the teaching of reading and the use of IWBs in the classroom, and the importance of allowing 'talk time' in the classroom.

Conclusion

The beginning of this thesis introduced a scenario witnessed by many teachers of students with intellectual disabilities. Students with special needs can encounter a myriad of hurdles before they come to school in the morning, such as not having their favourite socks to wear, a change in television programming or running out of their preferred breakfast cereal. Each of these has the potential to impact negatively on their engagement during lessons, as well as negatively influence the behaviour of others in their class. Student engagement is a key factor underpinning a student's ability to participate productively in learning activities at school and to ultimately learn new behaviours and skills which will help them in their future education (Fredericks et al., 2003), employment prospects and leisurely pursuits.

Many students with intellectual disability also have speech and language issues, having difficulties with receptive and expressive language, making learning to decode and comprehend text more difficult than their typically developing peers. This researched focussed on whether the IWB could be used as a teaching tool to help engage the five participating young students with Intellectual Disability in learning an aspect of phonological awareness more than the traditional desk top style of teaching.

Ehri's Phases of Reading Model (for example Ehri, 1991, 1995a; Ehri & Robbins, 1992) helped to identify the aspect of reading the students had reached prior to intervention, and the type of activities that could be undertaken to help engage them in the learning process and teach them a specific skill identified in the pre-test phase of the project. The lessons were planned and adapted drawing on the challenges identified when using an IWB as a guide (for example see Cutrim Schmid, 2008; Martin, 2007; Smith, 2001), as well as the principles identified in the cognitive load research Paas (2003), Sweller (2004, 2006) and van Merrienboer and Sweller (2005); and Mayer and colleagues' (Mayer, 2001, 2003, 2005a; Plass et al., 2003) multimedia research.

The results indicated the students could learn an aspect of phonological awareness when systematically and explicitly taught. However, there was no consistent pattern of preference between the two teaching methods in regards to the student's individual levels of engagement or the students' overall levels of engagement. Nor was there a difference in the rate in which they acquired the focus rimes or letters. The data was analysed using three methods of analysis: visual analysis, points of non over lapping data and randomisation test analysis, all of which are valid forms of analysis when undertaking an ATD approach. These multiple measures provided robust decision criteria on which to base discussion.

An important, and to some extent unexpected finding was the lower level of both relevant elaborations and irrelevant chatter when the students were performing IWB activities. Finding ways of encouraging students to elaborate upon what they are learning when using the IWB is a consideration software designers and teachers need to address to make this resource a quality teaching tool in the classroom. It may be that whole class instruction is more conducive to opening up dialogue, although this was not an area looked at in this research due to the single case approach of the project. Encouraging more elaborative elaborations should be possible with all students, and would be particularly beneficial to students with intellectual disability. This remains an important area of future research.

The planning of learning tasks that carefully scaffold learners in moving from what they know and are familiar with to learning new content or new tasks can be expected to lead to a decrease in avoidance behaviours and the perception of error making. Where this occurs the student's cognitive energies can be put towards the learning opportunity before them rather than other, non-productive pursuits. The findings here, especially those related to cognitive engagement, suggest that specific, explicit instruction in learning strategies will help build confidence within the students, improving their self-perceptions which would lead to greater engagement in lessons and learning.

This research was at odds with many of the claims previously made in regards to the benefits of IWBs in classrooms (for exampleBECTA, 2003; Cogill, 2003; Higgins et al., 2005; Smith et al., 2005). However, it did support many of the current practices used by teachers of students with special educational needs in regards to using a variety of interactive, multi-sensory teaching methods to engage the students in their pursuit of learning; and the structuring of lessons with explicit, clear instructions which scaffold students towards new learning opportunities, with a focus of just one or two skills to minimise the students' cognitive load. Providing opportunities for students to connect their learning experiences with their life experiences and teaching them to ask questions to improve their cognitive engagement with tasks would enhance their learning opportunities and assist with transference to other situations.

Furthermore, the use of educational software and new technologies to support learning outcomes can be successfully interwoven through teaching programs that draw on research based pedagogical practice. Students with intellectual disability need time to experiment, implement and refine their learning through repeated practice (Jonassen, 2013) in which they are encourage to ask questions, to connect with shared experiences and promote language production. Learning is purported to be easier with technology, leading to improved academic outcomes (Liu, Wu, & Chen, 2013), therefore more investigation and experimentation looking at the pedagogical approaches behind technology integration which actively promotes meta-cognitive awareness and skills which support student achievement should be of continued focus for future research.

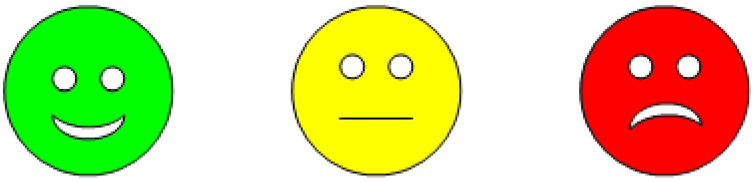
APPENDIX A

Student Engagement Rating Scale

	Really negative behaviours. No engagement behaviours displayed (Score 1)	Mildly negative behaviours. Passive, reluctant engagement behaviours displayed (Score 2)	Slightly positive behaviours. Few positive engagement behaviours displayed (Score 3)	Mostly positive behaviours. Mostly positive engagement behaviours displayed. Shows some spontaneous behaviour related to task. (Score 4)
Task engagement behaviours - Frequency of eye contact with teacher or task - Posture - Time on task	• No activity related to task, refuses to do task, pushes task away.	• On task rarely, reluctantly complies with instructions. Primary behaviour unrelated to task.	• On task some of the time, complies with instructions, but gets distracted, fidgety, does not perform task readily	• On task most of the time, performs task quickly and readily without interruption, attending.
	• No eye contact with teacher	• Looking towards teacher or activity, but not to engage.	• Eyes frequently on teacher or activity	• Predominantly watching teacher or activity
Affective engagement behaviours - Facial expressions, showing emotion. - persistence	• Sad, cries, pouts, angry, frustrated, tantrums.	• Not upset, but lacks real interest	• Shows some momentary, intense interest	• Shows sustained, intense interest
	• Child not enjoying self.	• Bored, expressionless	• Smiling, looks pleased	• Laughing appropriately, looking to interact with the Teacher, be part of the group.
	• No attempt to complete focus activity when persistence required	• Made some effort to complete focus activity with assistance when persistence required	• Made some effort on own, but also required assistance with focus activity when persistence required.	• Persisted with focus activity independently
Cognitive engagement behaviours	• **Selection** (use of material): *No sign* of selecting material	• **Selection** (use of material): selects material, but inappropriate to task	• **Selection** (use of material): selects some or part of the material, but not enough to complete task.	• **Selection** (use of material): selects correct material, completes task.
looking for any feature that connects material to anything the student knows or adds to the task	• **Elaboration** (relating to, or transformation of material): *no sign* of connecting material to prior learning	• **Elaboration** (relating to, or transformation of material): *with or without prompting*, but no clear connection with material. i.e. attempts to elaborate but comments unrelated to task i.e /i/ is for igloo when looking to read a word; no /i/ presented.	• **Elaboration** (relating to, or transformation of material): *with or without prompting* connects material with previous learning i.e. recognises written letter (selection) AND accurately produces sound (elaboration); recognises rime, then recalls other relevant words / ideas.	• **Elaboration** (relating to, or transformation of material): *no prompting required*, connects material with an original elaboration; extends ideas; creates other relevant words. Can include non-verbal responses i.e. writing, sign language. Can use pictures, letter clues, context to aid understanding
self-correction, questioning	• **Monitoring**: *no sign* of relevant questions, self-correction, recognition of error	• **Monitoring**: *with prompting* shows some recognition of error, but no clear connection or questions related to task.	• **Monitoring**: *with prompting* recognises error, some comments related to error and / or task. No relevant questioning.	• **Monitoring**: *with no prompting* self-corrects, asks relevant questions. Can include statements about the task, the environment.
Progress with a problem in terms of accuracy	• **Problem solving**: no progress or not required	• **Problem solving** : some progress with much assistance	• **Problem solving** : attempts on own, partially correct	• **Problem solving** carries out task spontaneously and accurately

APPENDIX B

Faces from the 'Feelings Program'



APPENDIX C

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CRICOS Provider No. 00114A

LETTER OF INTRODUCTION

Dear Parent/Carer,

This letter is to introduce Carol Le Lant who is a PhD student in the School of Education at Flinders University. She will produce her student card, which carries a photograph, as proof of identity.

Carol is undertaking research leading to the production of a thesis or other publications on the subject of "*The impact of Interactive Whiteboards on engagement in the acquisition of reading skills in children with special needs*". The research project is part of a larger program of research funded by the Australian Research Council, and in which the Department of Education and Children's Services (DECS) is a partner. The findings from this project are expected to be of interest to other schools and to DECS.

Carol's thesis aims to examine the impact of the use of Interactive Whiteboards for the presentation of a synthetic (explicitly taught) phonics program on student engagement in reading and the impact of the use of an Interactive Whiteboard of a synthetic phonics program on student reading performance.

The children involved will participate in a structured program conducted over 1-2 terms, involving up to 50 hours of instruction (20-30 minutes per session). The program will cover the students' regular reading curriculum, although will require your child to be withdrawn from their regular class activities. The synthetic phonics program is a beginning reading program that is carefully structured to teach children the word attack, comprehension and spelling skills they need to become effective readers. The children are directly taught skills such as letter-sound relationships, and the blending and segmenting of words. The interactive nature of the program aims to motivate and engage the students so that they master the skills taught in this beginning reading program.

If you wish to participate in a demonstration of the Interactive whiteboard and the phonics program, please complete the details on the attached consent form.

In the event your child becomes upset or distressed during these lessons, the lessons will stop immediately and your child will be taken back to class. You will also be informed if this situation arises.

Your child may be video taped during some of the lessons to enable information such as time spent getting settled on the task, time spent on the task and anecdotal comments to be recorded. These images will not be made public, nor labelled in an identifiable form.

Carol would be most grateful if you would volunteer to assist in this project, by granting consent for your child to participate in the interactive whiteboard literacy lessons during Term 3 and 4, 2008. Students who do not participate in this program will undertake their regular school programs.

The information Carol will gather in this project will remain confidential and there will be nothing in the report on the project that will allow identification of the names or responses of any participants, or of the school. In seeking your permission for your child to participate, it is understood that participation is voluntary and that you or your child may decide to withdraw from the project at any time without fear of prejudice.

A consent form is attached for you to sign. If you have any enquiries concerning this project, they should be directed to me at the address given above, by telephone on (08) 8201 2829 or e-mail mike.lawson@flinders.edu.au

Thank you for your assistance,

Yours sincerely,

Prof Mike Lawson
School of Education

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee. For more information regarding ethical approval of the project the Secretary of the Committee can be contacted by telephone on 8201 5962, by fax on 8201 2035 or by email sandy.huxtable@flinders.edu.au.

APPENDIX D

Randomizer results – acceptable repeat options (NO MORE THAN 3 REPEATS)

Odd number = treatment A (IWB) Even number = Treatment B (non-IWB)

Set 1
ABA BBA BBA ABA AAB BAA BB

Set 2
BAA BAB ABB ABA ABB BAB AA

Set 3
BBB AAA BAB AAB BAA BAA AB

Set 4
AAA BBA ABA BAA BBA BBA BB

Set 5
AAB BAB ABA BAB ABB BAB AA

Set 6
BAA ABB ABB ABB ABA BAB AA

Set 7
AAB ABA BBB AAB ABB BAA BA

Set 8
BAB BBA BBA AAB ABA BAB AA

Set 9
AAB ABB BAA BBA BAB BAA BA

Set 10
BBA BBB AAB ABA BBA ABA AA

Set 11
ABA BAA BBA BBB ABA AAB AB

Set 12
ABB ABA BAA BAB ABB AAB BA

APPENDIX E

Martin's Error Profile

IWB	1 (L2)*	2 (L3)*	3 (L5)*	4 (L8)	5 (L9)	6 (L11)	7 (L12)	8 (L14)	9 (L15)	10 (L17)*
Recording interval	4th of 6	7th of 9	3rd of 14	3rd of 13	5th of 11	4th of 9	3rd of 19	1st of 7	7th of 10	9th of 10
Activity	Dragging letters into position	Reading Doc program.	Introducing the word with a matching picture. (new rime)	Sounding and blending words with their matching picture.	Dragging letters into position	Identify and write the first sound of word (new rime)	Word-picture-word matching	Cloze activity	Revision of first rime	Reading all the IWB rimes in a story
Error / difficulty	Identified first and final position of letters. Trouble with middle.	No error – perceived level of difficulty?	Match word with picture	Confusion with b/d	Identified first and final position of letters. Trouble with middle. Successful with b/d	Reading what is on the board rather than what is not.	Trouble identifying the /mug/ picture.	Sounding, then recalling previously learnt or known words i.e. /tug/ = /tag/; / mug/= /cup/	Sounding and blending most words, trouble with /mat/. Recovered from this	Not fully on task entire lesson, overcome by the amount of words in the 9th recording interval.
Reaction	Presses buttons on board, page 'disappears'. Body floppy, looking around the room, checking other computers	Shuts the program down.	Joining lines, scribbling, erasing	Changing the colour of the pen, questions about the wand (stylus for IWB) erasing, writing	Tapping on board to make sounds, writing, not answering questions, shuts program down.	Changing pen colour, erasing, playing with chair, swapping writing hands, shuts program down.	Not looking at the board, therefore cannot complete the task. Prompted to look at the words, the pictures.	Drawing circles around words, changing from pen to pointer	Drawing random lines, came back on task.	Scribbling on pages, erasing, attending to other noises

Non-IWB	1(L1)	2 (L4)	3 (L6)	**4 (L7)***	**5 (L10)***	**6 (L13)***	**7 (L16)***	**8 (L18)***	**9 (L19)***	10 (L20)
Recording interval	4th of 7	6th of 7	1st of 11	11th of 12	7th of 14	**none**	1st of 10	**none**	**none**	1st of 10
Activity	Introducing new words with the magnets and cards.	Cloze activity (successfully completed two short activities)	Revision of first rime.	Word bingo	Cloze activity (new rime)	Comprehension, word/picture matching	Revision	Revision, caterpillar game	Bingo	Reading all non-IWB target rimes in a story
Error / difficulty	Confusion p/b/d	sentences	Confusion p/b/d	Confusion with p/d			/red/ = /fed/ **Recovered**		Refused to go on with another activity	Reading the pictures, showing comprehension, but struggling with words.
Reaction	Out of seat, looking out window. Got back on task 5 minutes later with a familiar game of memory.	Sliding down chair, drawing, copying non-target words	Fiddling with magnets, swinging his legs.	Slouching, protesting *"I don't want to play this anymore'*	Playing with the coloured pencils, but **recovers to complete the lesson with a cheerful *'this is hard work'*.** Seemed very proud of himself.		Playing with magnets, but **comes back to the task**			*'Too many words'* slouching, playing with his ear.

* more tasked engaged in this condition

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