



UNIVERSITY OF CAPE TOWN
FACULTY OF HEALTH SCIENCES



DEPARTMENT OF HEALTH AND REHABILITATION SCIENCES
DIVISION OF COMMUNICATION SCIENCES AND DISORDERS

**The effectiveness of the Virtual Reading Gym online intervention for grade three to six learners
with reading difficulties**

A dissertation presented in fulfilment of the requirements for the degree of Master of Science in
Speech-Language Pathology to the Division of Communication Sciences and Disorders

Degree: MSc in Speech-Language Pathology by dissertation

Course code: MM009

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Date of submission: 09/09/2019

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Acknowledgements

I would like to thank my supervisor, Dr Michelle Pascoe, for making the degree a wonderful experience. Thank you for being absolutely committed to the process, going the extra mile, making helping me a priority, providing invaluable feedback on my work and remaining positive throughout. Thank you for guiding my learning and helping me to always have a clear direction of where the project was going. I appreciate your kindness, gentleness and the positive affirmation you give so freely. I admire you very much.

Thank you to my co-supervisor, Jane le Roux, for your optimism and encouraging feedback on my work. I respect your ability to remain cheerful and calm regardless of your work demands.

Thank you to my mother, Cathy Dean, for believing in me and helping me to believe in myself. Mom, thank you for being a constant source of support in my life.

Thank you to my siblings, Richard and Leanne Dean, for cheering me along every step of the journey.

Thank you to the school principal, therapists and teachers for being welcoming, friendly and accommodating. Thank you to the children who participated enthusiastically. It was a delight working with you.

Thank you to Kate Rossouw and Lize Mostert for being brilliant speech-language therapists/ research assistants. Thank you for diligently devoting your time and effort to providing therapy to the children who participated in the study.

Thank you to Lezanne de Villiers for being warmly supportive of me during my studies and for kindly arranging flexible study leave from my hospital work.

Thank you to Elizabeth Nadler-Nir, the speech-language therapist who invented the Virtual Reading Gym. Your passion for literacy and working with children is an inspiration to me.

Abstract

Background

Research suggests that most South African learners are not achieving the expected literacy outcomes of their grades. Compounding the literacy crisis is the paucity of South African research related to information and communication technology (ICT)-based reading intervention, which may have potential for population-based service delivery.

Aims and Objectives

The aim of the study was to determine the effectiveness of the Virtual Reading Gym (VRG) online intervention for grade 3 to 6 learners with reading difficulties. The objective was to describe changes in learners' reading skills (accuracy, rate, vocabulary and comprehension) after VRG intervention.

Design

Two studies were carried out: (1) A retrospective analysis used data from a previous study conducted in mainstream schools which used peer reading mentors; (2) A prospective study in a school for learners with special educational needs that had speech-language therapist led intervention. Both studies used matched subject pre/ post intervention designs.

Methods and Procedures

In Study 1, matched pairs were retrospectively created to form a sample (n=20, 8 males and 12 females, 10 intervention group and 10 control group) of grade 3 to 6 learners. In Study 2, the prospective study, participants (n=20, 14 males and 6 females, 10 intervention group and 10 control group) were grade 3 to 6 learners from a school for learners with special educational needs in Cape Town. For both studies, the intervention group received VRG intervention 3 times per week (30 minutes per session) for 10 weeks. The control group continued with regular school activities. Independent samples t-tests for gain scores were used to analyse results. Semi-structured interviews were conducted with intervention participants from the prospective study. Thematic analysis was used to interpret the transcribed interview data.

Results

For the retrospective analysis there were no statistically significant differences between the intervention and control groups' reading accuracy, rate, vocabulary and comprehension improvements at the completion of the VRG intervention. Similarly, the prospective study found no statistically significant differences between the reading accuracy, vocabulary or comprehension gains of learners in the intervention and control groups. However, there was a statistically significant difference between the groups' gains on one measure of reading rate. The thematic analysis findings were that learners expressed enjoyment of the VRG and intervention experiences, valued the role of the reading partners, believed they had made literacy skill gains, described self-competency improvements, expressed the belief that the VRG could result in reading improvements, and portrayed positive attitudinal and behavioural changes related to reading.

Discussion

The study contributes by investigating the potential of one practical solution to South African learners' reading difficulties and adding to the limited local evidence base on ICT reading intervention. Although an intervention effect could not be demonstrated in this study, the changes noted in reading rate and qualitative findings suggest the potential for impact. The discussion considers some explanations for the findings, suggestions for improving interventions such as the VRG, and lines of future research that could be developed to support South African children in their struggles with reading.

Key Words

The Virtual Reading Gym, Information and Communication Technology, reading intervention, primary school children, South Africa

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Abbreviations

ADHD:	Attention deficit hyperactivity disorder
ASD:	Autism spectrum disorder
Grade R:	Grade reception
HL:	Hearing loss
ICT:	Information and communication technology
LSEN:	Learners with special educational needs
PD:	Physical disability
RTI:	Response to intervention
SLD:	Specific learning disability
SLT:	Speech-language therapist
VRG:	Virtual Reading Gym

Chapter One

Overview of Context and Reading

1.1. Introduction to Chapter

The current study investigated the effectiveness of an online reading intervention for children with reading difficulties. This chapter provides an overview of the context of the study. First, national and international research which demonstrates that there is a crisis in South African learners' reading performance will be described, the factors related to the crisis will be discussed, and the historical background of education in South Africa will be explored. Second, information related to multilingualism, the importance of the language of learning and teaching and the role of the speech-language therapist (SLT) in the education sector will be outlined. Lastly, models for understanding typical reading development, word reading and reading difficulties will be discussed.

1.2. The Importance of Reading

Reading is one of the most crucial skills that children develop at school (Armbruster, 2010; Duncan et al., 2007; Hernandez, 2011; Mullis, Martin, Foy, & Hooper, 2017; Mullis, Martin, Kennedy, Trong, & Sainsbury, 2009). Reading is the foundation on which learning occurs in all school subjects (Kathard & Moonsamy, 2015; Mullis et al., 2009; Mullis et al., 2017). Poor reading performance is associated with reduced school academic achievement, dropping out from school, and diminished education, training and employment opportunities (Cooper, Moore, Powers, Cleveland, & Greenberg, 2014; Hannon, 2000; Hernandez, 2011; Spaul, 2013b; Yap & Liow, 2016). Reading is not only necessary for the realisation of educational and livelihood opportunities but for general community and societal participation as well (Organisation for Economic Cooperation and Development [OECD], 2010; Owens, 2012; Rose, 2006; Snowling, Adams, Bowyer-Crane, & Tobin, 2000; Taylor, Duff, Woollams, Monaghan, & Ricketts, 2015). It is therefore of utmost importance that children develop strong reading skills.

1.3. The South African Educational Context

1.3.1. Crisis in education and children's reading performance.

A crisis in basic education has been described in South Africa (Kathard et al., 2011; Spaul, 2013b). National and international studies over the past two decades show that the majority of South African learners are not meeting the expected literacy outcomes of their grade (Department of Basic Education, 2008; Department of Basic Education, 2011; Department of Basic Education, 2012; Department of Basic Education, 2013; Department of Basic Education, 2014; Foy, Martin, & Mullis,

2010; Howie et al., 2017; Moloï & Chetty, 2010; Moloï & Strauss, 2005; Mullis, Martin, Foy, & Drucker, 2012; Mullis, Maartin, Kennedy, & Foy, 2007; Mullis, Martin, Foy, & Hooper, 2017; Spaul, 2013b; Taylor, 2011a; Taylor, Fleish, & Schindler, 2008). This is a complex and multifaceted problem documented over several years and is linked to the country's fraught political and social challenges.

Research related to South African learners' primary school literacy achievement has consistently shown poor results. The South African Systemic Evaluations found that grade three learners achieved an average of 30 percent in literacy assessments in 2001 and 36 percent in 2007 (Department of Basic Education, 2008). The 2003 Western Cape Learner Assessment study revealed that only 35 percent of grade six learners were performing at the appropriate literacy level (Taylor et al., 2008). The 2007, 2008 and 2009 South African National School Effectiveness study found that grade three to five learners scored between 17 and 27 percent in the literacy evaluations (Taylor, 2011a). The 2011, 2012, 2013 and 2014 South African Annual National Assessments (ANA) revealed that the majority of learners in grades one to six and grade nine were performing significantly below the expected literacy and language levels for their grade (Department of Basic Education, 2011; Department of Basic Education, 2012; Department of Basic Education, 2013; Department of Basic Education, 2014; Spaul, 2013b). The results of these local studies reveal the dire state of education in the country, with literacy challenges lying at the heart of the difficulties.

South Africa participated in the second and third studies conducted by the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) (Moloï & Strauss, 2005; Moloï & Chetty, 2010). Fourteen African countries took part in the second study in 2000 and fifteen African countries participated in the third study in 2007. The SACMEQ study investigated the reading and mathematics performance of grade six learners. The results of the reading component of the study showed that the percentage of South African learners demonstrating acceptable reading skills, defined as the ability to read for meaning by linking and interpreting information in a text, was 49.9 in 2000 and 51.7 in 2007 (Moloï & Strauss, 2005; Moloï & Chetty, 2010). These findings indicate that there was no significant improvement in literacy performance over the seven-year period and that only 50 percent of South African grade six learners can understand what they read (Spaul, 2013b). In the 2007 study, South Africa's reading performance was ranked tenth out of the fourteen education systems represented by the fifteen African countries (Moloï & Chetty, 2010). A high proportion (40.2 percent) of South African grade six learners were classified as "non-readers" in the 2007 study because they had emergent reading skills and were not able to read words in short sentences.

The Progress in International Reading Literacy Study (PIRLS) was inaugurated in 2001 by the International Association for the Evaluation of Educational Achievement (Mullis et al., 2017). It has been conducted every five years since 2001 and assesses the reading and reading comprehension

achievement of grade four learners. Grade four learners are assessed because they are expected to have mastered the skill of ‘learning to read’ and now be ‘reading to learn’ (Mullis et al., 2017). South African grade four and five learners participated in the 2006, 2011 and 2016 cycles of PIRLS (Howie et al., 2017). In all cycles, the PIRLS made use of a nationally representative South African sample. The PIRLS results showed that South African learners performed the most poorly out of all the participating countries and performed significantly lower than the international average in all three cycles (Foy et al., 2010; Howie et al., 2017; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017). There was no statistically significant difference between learners’ scores in 2006, 2011, and 2016 suggesting that reading performance did not improve in South Africa over the ten-year span. The results of the 2016 PIRLS cycle will be described in more detail in the following paragraph.

The PIRLS international reading literacy scale has a range from 0 to 1000, a mean of 500 and a standard deviation of 100 (Howie et al., 2017). For the 2016 PIRLS, the mean score for South African learners was 320 which ranked South Africa the lowest out of the 50 participating countries (Mullis et al., 2017; Howie et al., 2017). The four international benchmarks (low, intermediate, high and advanced) offer information related to what reading skills learners have at different score point ranges (Howie et al., 2017). Learners who do not reach the first benchmark (below 400 points) “cannot read for meaning or retrieve basic information from the text to answer simplistic questions” (Howie et al., 2017, p. 4). Learners who reach the low international benchmark (400 to 474) can read to find and retrieve information which is explicitly stated (Howie et al., 2017). The 2016 PIRLS results reveal that 78 percent of the South African learners did not meet the lowest benchmark, revealing that they could not understand, locate or reproduce explicit information from a text. In stark contrast, the international average of learners that did not meet the lowest benchmark was 4 percent (Howie et al., 2017). PIRLS results indicate that most South African grade four children have exceptionally weak reading skills.

The achievement of South African learners in the PIRLS and SACMEQ is extremely poor and yet, some researchers argue that national averages in fact overestimate the performance of most learners (Fleisch, Taylor, Schöer, & Mabogoane, 2017; Spaul, 2013a). This is because of a distribution which is skewed to the right by the high performance of children from well-resourced, traditionally privileged schools (Fleisch et al., 2017; Spaul, 2013a). It should thus be recognised that the majority of South African children’s reading scores are likely lower than the figures represented in the studies.

National and international research provides strong support for the crisis in education in South Africa. Most South African learners are not achieving the expected literacy outcomes for their grade and their literacy skills are significantly poorer than those of their international peers. The findings are a major cause for concern and require urgent attention.

1.3.2. Factors related to the reading performance.

The school-based characteristics associated with South African learners' poor literacy performance include children not attending preschool, limited funding, poor functioning of school governing bodies, unsafe schools, lack of discipline, repeated curriculum changes, insufficient learning and teaching resources, schools not having libraries, and schools being located in rural areas and townships due to factors such as increased travel time and safety (Graven, 2014; Howie et al., 2017; Kathard et al., 2011; Modisaotsile, 2012; Mullis et al. 2017; Taylor & von Fintel, 2016).

Teacher factors play a critical role in learners' outcomes as well. The teacher factors correlated with poor learner literacy achievement include poor teacher training, low teacher literacy levels, poor teacher subject knowledge, inadequate teacher support, high rates of teacher absenteeism, insufficient time spent on teaching, failing to follow and complete the curriculum, not giving homework to learners, ineffective use of resources, having low expectations of the learners, providing poor quality reading instruction and not providing sufficient opportunities for learners to engage in reading and writing tasks (Fleisch, 2008; Graven; 2014; Hoadley, 2012; Howie et al., 2017; Justice, 2006; Kathard et al., 2011; Kathard et al., 2011; Nadler-Nir & Pascoe, 2016; Taylor & von Fintel, 2016; van Staden & Bosker, 2014; Wium, Louw, & Eloff, 2010).

Parental factors are additionally linked to weak learner literacy skills. Such factors are poverty, low parental literacy levels, low parental educational and occupational levels, parents not reading for pleasure, parents not engaging in literacy activities with their children, lack of parental involvement in their children's education, and lack of home resources such as books (Howie et al., 2017; Modisaotsile, 2012; van Staden & Bosker, 2014).

Lastly, learner factors associated with poor literacy include poverty, learning in a second or additional language, having a language or reading impairment, low motivation to read, negative attitudes towards reading, high absenteeism, high rates of bullying, substance abuse, hunger, tiredness, and health conditions (e.g., malnutrition, hearing loss, foetal alcohol syndrome, and HIV/AIDS) (Fleisch, 2008; Hoadley, 2012; Howie et al., 2017; Justice, 2006; Modisaotsile, 2012; Mullis et al. 2017; Taylor & von Fintel, 2016; van Staden & Bosker, 2014).

Evidently, a broad array of systemic, social and economic factors contributes to the complex literacy crisis faced in the country. The next section of the chapter explores the political roots of the reading performance issue.

1.3.3. Historical background to education in South Africa: Apartheid.

The period of apartheid (1948 to 1994) was characterised by racial segregation, injustice and inequality. In 1948 the National Party came into power in South Africa and implemented a system of

regulation based on racial segregation ideology. Apartheid was established on a long history of colonial rule and racial segregation policies (Graven, 2014; Lear, 2018; McKeever, 2017). The legacy of colonialism and apartheid in South Africa has resulted in grave consequences for the education system (Fleisch, 2008; Spaul, 2013a; Spaul, 2013b).

The Bantu Education Act of 1953 passed the segregation of the education system into law (Lear, 2018). It established federal control of education for black¹ learners (Graven; 2014; McKeever, 2017). In the 1960s, the Bantu Education Act was extended to include all learners who were not white² (e.g., the Coloured³ Education Act and the Indian⁴ Education Act) (Graven, 2014; McKeever, 2017). It limited the quality and quantity of education which South Africans who were not white could receive, removed provinces⁵ ability to make decisions related to education and administration, and made it illegal for schools for learners who were not white to be opened without the permission of the Union of South Africa's⁶ National Party⁷ Minister of Native Affairs⁸ (Lear, 2018). All schools for learners who were not white (known as Bantu schools) became state-run and the Minister of Native Affairs was given the authority to close schools, suspend school grants, and manage the allocation of finances (Lear, 2018; Moore, 2016).

The Bantu Education Act resulted in vastly different regulations, curricula and funding for the different racially-defined schools (Fleisch, 2008; McKeever, 2017; Navsaria, Pascoe, & Kathard, 2011; Spaul, 2013a). Schools for white learners had higher mandatory levels of education, emphasised academic subjects and received large amounts of funding (Graven, 2014; McKeever, 2017). In contrast, schools for learners who were not white had lower mandatory levels of education, lower academic expectations, larger class sizes, less qualified teachers, focused on practical skills and subjects which equipped learners for blue-collar work, and received less government funding (Kathard et al., 2011; Lear, 2018; McKeever, 2017; Moore, 2016).

1.3.4. Law and policy changes since 1994.

In 1994, South Africa became a democracy. In 1996, the Constitution of the Republic of South Africa was adopted by parliament and signed into law. The progressive constitution emphasised equality and human rights, including the right to education (Republic of South Africa, 2014; Deveaux, 2003; United Nations, 1948). The new government prioritised quality primary and secondary education,

¹ African ethnicity

² European ethnicity

³ Mixed ethnicity

⁴ Indian ethnicity

⁵ An administrative division with its own legislature, premier and executive council. Before 1994 South Africa had four provinces. Since democracy South Africa has had nine provinces.

⁶ The predecessor to the current-day Republic of South Africa

⁷ The ruling political party during apartheid

⁸ A political position during apartheid

making many changes to redress the inequalities of the past (Badat & Sayed, 2014; Graven, 2014; Nadler-Nir & Pascoe, 2016; Salisbury, 2016; Sayed & Kanjee, 2013). A description of the significant developments in education post 1994 follows.

In 1995, the White Paper on Education and Training affirmed that all South African citizens would have the same opportunity for learning experiences (Department of Education, 1995). The following year the National Education Policy Act of 1996 was passed to ensure that the national education system would be transformed to serve all South African individuals and uphold their rights (Republic of South Africa, 1996b). In 1997, the South African Schools Act established that schools were to be run by elected school governing bodies (comprised of teachers and parents) while principals conduct the professional management of schools (Badat & Sayed, 2014; Lear, 2018). The South African Schools Act gives governing bodies the power to select their school's language of learning and teaching (Lear, 2018). An education system supportive of multilingualism was created through the 1997 Language in Education Policy (Badat & Sayed, 2014; Kathard et al., 2011; Spaul, 2013a).

National Norms and Standards for School Funding were passed in 1998. This established an equity-focused form of school financing (Badat & Sayed, 2014). In 1997 the curriculum was changed to Outcomes-Based Education; in 1998 a regime of continuous assessment was introduced and in 2002 the Revised National Curriculum Statement for grades reception (R) to nine was released (Badat & Sayed, 2014; Kathard et al., 2011). The 2001 White Paper 6 on Special Needs Education addressed the important areas of learner inclusion and support.

With the collapse of apartheid, the racially defined departments of education were abolished, and a new national department of education was formed. In 2009, two departments of education were developed: (1) the Department of Basic Education (primary and secondary schools) and (2) the Department of Higher Education and Training (tertiary education) (Badat & Sayed, 2014; Lear, 2018). The Department of Basic Education has nine departments, one responsible for each South African province (Lear, 2018; Spaul, 2013a).

1.3.5. Funding and segregation changes since 1994.

The racially skewed allocation of resources which took place during apartheid has been eliminated. Today all schools and institutions are allocated resources based on a funding formula not influenced by race. Provinces are provided with equitable funding (based on rural population size, poverty indices, and the proportion of the population requiring social grants) to ensure that all children have an equivalent amount spent on them (Badat & Sayed, 2014). Additionally, schools are now classified into one of five quintiles based on the socioeconomic status of the surrounding area; provinces are

expected to provide 60 percent of the resources to the poorest 40 percent of learners (schools in quintile one and two) (Badat & Sayed, 2014; Kathard et al., 2011).

Since democracy, schools and higher educational institutions are no longer segregated by race (Badat & Sayed, 2014). However, the historical geographical living areas of race groups and social class now have an impact on schooling because of the existing educational policy which allows school governing bodies to make their own decisions related to the charging of school fees (Spaul, 2013a; Badat & Sayed, 2014). Consequently, effective schools are typically in expensive neighbourhoods far away from where most black learners live and are therefore often geographically inaccessible (Spaul, 2013a). Effective schools typically have higher school fees which make them financially inaccessible to many as well (Spaul, 2013a). Middle-class black, coloured and Indian learners have moved to formerly white schools; but movement has not occurred in the opposite direction (Kathard et al., 2011; Spaul, 2013a). Wealthy and middle-class children attend formerly white fee-paying and private schools in historically white areas; children from the working class and poor rural areas attend historically black schools (Badat & Sayed, 2014; Graven, 2014; Kathard et al., 2011). Public (government) schools mostly serve the black population and those in poverty while children from wealthier backgrounds attend semi-private and private schools (Badat & Sayed, 2014; Kathard et al., 2011). Manifestly, the financial inequality and spatial segregation of apartheid continue to influence South African learners' ability to access quality education.

1.3.6. Bimodal distribution of achievement in schooling.

South Africa is one of the most unequal countries in the world and many maintain that it is both a developed and developing country (McKeever, 2017). It is therefore not surprising that the education system has a bimodal distribution of achievement. This refers to the two separate trends which occur simultaneously in education (Fleisch, 2008; Graven, 2014; Spaul, 2013a; Taylor, 2011b). The majority of learners (approximately 75 percent) have low socioeconomic status, attend disadvantaged schools, speak an African home language, perform extremely poorly on local and international educational achievement tests and cannot read adequately in the language of instruction. In contrast, a minority of learners (approximately 25 percent) have high socioeconomic status, attend functional schools, speak English as a home language, perform acceptably on local and international tests, and have grade-appropriate reading performance (Badat & Sayed, 2014; Fleisch et al., 2017; Fleisch, 2008; Spaul, 2013a; Taylor, 2011a).

Despite the progressive constitution and changes in policy, South Africa's education system remains in a state of crisis. South African children are not gaining adequate literacy skills due to a complex interplay of systemic, political, social and economic factors.

1.3.7. Multilingualism and literacy in South Africa.

With the collapse of apartheid, multilingualism became a feature of the new government (Lear, 2018; Shepherd, 2018). First, the Pan-South African Language Board (PANSALB) was formed by the Pan-South African Language Board Act of 1995. PANSALB is an independent language agency with the role of developing and promoting multilingualism and the national languages; protecting language rights; and providing advice and recommendations to the government on language legislation, language policy and language use matters (Lear, 2018). Second, South Africa adopted eleven official languages when it reconstructed its constitution (Lear, 2018; Pascoe, Klop, Mdlalo, & Ndhambi, 2018; Van der Walt & Evans, 2017). The Constitution of the Republic of South Africa (1996) declares that there are eleven official languages in South Africa. Third, the South African Schools Act of 1996 declares that provisions must be made for learners to receive schooling in their language of choice (Lear, 2018; Shepherd, 2018). Lastly, the Language in Education Policy was introduced in 1997 to protect linguistic diversity and promote language equity (Lear, 2018; Shepherd, 2018).

The most widely spoken languages in South Africa are isiZulu (22.7 percent), isiXhosa (16 percent), Afrikaans (13 percent) and English (9.6 percent) (Statistics South Africa, 2011). English is one lingua franca among many in South Africa (Van der Walt & Evans, 2017). However, English is perceived as the language of prestige and has a reputation of offering empowerment by promoting social, educational and economic opportunities (Jordaan, 2015; Lear, 2018; Van der Walt & Evans, 2017). English is spoken as a home language by a small minority and yet it is the dominant language of the public domain, government, law and education (Statistics South Africa, 2011; Taylor, 2011b; Van der Walt & Evans, 2017). The grade twelve final school leaving examinations can only be written in English or Afrikaans and English is the main language of learning and teaching in higher education (Taylor & von Fintel, 2016). Thus, English is used in formal domains while African languages are used in informal domains and spoken extensively in communities and families (Van der Walt & Evans, 2017).

School governing bodies decide on the language of learning and teaching of their school (Taylor & von Fintel, 2016). Most governing bodies select English or Afrikaans (Lear, 2018). The Language in Education Policy as well as the national and provincial departments of education promote additive bilingualism where a learner's home language is maintained and used as the language of learning and teaching until grade three before a supported transition is made to English or Afrikaans instruction in grade four. Most schools in rural areas and townships follow this approach (Kathard et al., 2011; Lear, 2018; Nadler-Nir & Pascoe, 2016; Taylor & von Fintel, 2016). In contrast, some schools choose to instruct in English from the beginning (Nadler-Nir & Pascoe, 2016; Taylor & von Fintel, 2016). Both approaches are problematic because many children are exposed to a number of languages at home and in the community before they are exposed to English (English is not necessarily their second

language), learners are expected to learn in English without having had the opportunity to develop sufficient competence, and they have little or no exposure to English as a subject before the transition is made in grade four (e.g., in grades R to three learners are typically taught English conversational skills which does not prepare them to learn core curriculum subjects in English) (Heugh, 2005; Jordaan, 2011; Kathard et al., 2011; Nadler-Nir & Pascoe, 2016). Hence, despite the language-related law and policy changes post-apartheid, language factors play a role in South African children's educational outcomes.

1.3.8. Impact of language of learning and teaching on literacy.

Many researchers consider instruction in a second or additional language to be strongly linked to underachievement in education (Alexander, 2005; Brock-Utne & Skattum, 2009; Heugh, 2009; Webb, Lafton, & Pare, 2010). However, the impact of language factors on the poor literacy performance rates in South Africa is not clear due to its association with variables such as socio-economic status, historical disadvantage, school location, teaching quality, and school management (Shepherd, 2018; Taylor & von Fintel, 2016). Thus, research related to learning in an additional language is explored in the following paragraph.

Most pedagogical theory is supportive of the practice of first language instruction until learners become academically proficient in the language (which may take three to eight years) over the practice of second language instruction from the beginning of primary school (Hakuta, Butler, & Witt, 2000; Heugh, 2005; Shepherd, 2018). According to a South African study by Taylor and von Fintel (2016), instruction in the home language in grades one to three led to greater English proficiency in grade four to six compared to instruction in English from grade one. Research has found that learners who receive home language instruction for longer periods of time while the second language is learned as a subject, perform better in their second language and other core subjects than learners who receive home language instruction for shorter periods (Alvear, 2019; Heugh, 2005; Shepherd, 2018). Furthermore, a review of relevant literature concluded that high levels of competence in the native language supports the acquisition of language and literacy skills in the second language, learners need instruction in both spoken and written language skills of the language of learning and teaching for literacy instruction to be successful, acquisition of literacy skills in the home language promotes acquisition of literacy skills in the second language and children perform better in reading when they receive instruction in their first language and the language of learning and teaching than when they only receive instruction in the language of learning and teaching (Alvear, 2019; August & Shanahan, 2006; Paradis, Genesee, & Crago, 2011; Shepherd, 2018).

Additive bilingual approaches foster high levels of bilingual proficiency in children. Bilingualism is beneficial for personal, psychological, social, cognitive, educational and economic reasons (Alvear, 2019; Bialystok 2018; Christian, 2016; Cummins, 2017; Dicks & Genesee, 2016; Paradis et al., 2011; Shepherd, 2018). Therefore, an additive bilingual approach has the potential to succeed in the South African school system. However, attention should be paid to supporting the first language and providing the time (in years) and opportunity (in quality instruction) for learners to become truly proficient in the second language before a transition occurs. As recommended best practices are not currently being implemented, language is likely one of the many factors involved in children's reading underperformance.

1.3.9. Speech-language therapists in the education system.

SLTs are specialists in spoken and written language development. Their knowledge of speech, receptive and expressive language, phonological awareness, reading, spelling and writing make them well-equipped to provide school-based services (Bishop & Snowling, 2004; Ehren, 2009; Jordaan, 2011; Kathard et al., 2011; Moonsamy, 2015; Owens, 2012; Wium & Louw, 2013). SLTs have an important role to play in the South African education system through supporting the literacy development of all children and providing intervention to children at risk of and presenting with speech, language and literacy difficulties (e.g., small group and individual therapy) (Bishop & Snowling, 2004; Ehren, 2009; Jordaan, 2011; Kathard et al., 2011; Moonsamy, 2015; Nadler-Nir & Pascoe, 2016; Owens, 2012; Stackhouse & Wells, 1997, 2002; Wium & Louw, 2013).

Despite the important role SLTs may fulfil in the education system, there are many barriers preventing optimal service delivery. SLTs comprise a small professional group in the country (the ratio of registered SLTs to the population is estimated to be approximately 1:25, 000), most are first language English or Afrikaans speakers and thus do not represent the cultural and linguistic diversity of the nation, there is a shortage of culturally and linguistically relevant assessment and therapy resources, the majority of SLTs work in the private rather than public sector, and, of the SLTs working in the public sector, most work within the health and not the education system (Barratt, Khoza-Shangase, & Mismang, 2012; Kathard & Moonsamy, 2015; Kathard & Pillay, 2013; Mdlalo, Flack, & Joubert, 2016; Moonsamy, 2015; Pascoe & Norman, 2011; Pascoe et al., 2018; Pascoe, Rogers, & Norman, 2013; Penn, 2002; Smit, Van den Berg, Bekker, Seedat, & Stein, 2006; Southwood & Van Dulm, 2015; van der Merwe & Le Roux, 2014).

These difficulties stem from the country's history of inequality. During apartheid, SLTs worked at the district level for the provincial departments of education and at schools for learners with special educational needs (LSEN) (Kathard et al., 2011). Post-apartheid, many of the SLTs employed in the education system became district facilitators and stopped providing direct services, resulting in no support or services for teachers and learners in public and mainstream schools. Thus, to this day,

SLTs in the education sector mostly work in schools for LSEN and those working in mainstream schools are paid by parents who can afford the fees or have medical aid (Kathard et al., 2011; Kathard & Moonsamy, 2015; Nadler-Nir & Pascoe, 2016). Clearly there is a need for innovative solutions to be developed so that SLTs can reach the large population of learners in need.

1.4. Reading

1.4.1. Biological basis of reading.

Reading is a complex process which depends on decoding (the ability to recognise novel and familiar words); fluency (accuracy, automaticity, rate and prosody); and comprehension (understanding the meaning of the text) (Hulme & Snowling, 2016; National Reading Panel, 2000; Snowling & Hulme, 2011; Taylor et al., 2015). Spelling and writing are important aspects of literacy not discussed here, as the current study focused on reading.

In contrast with the challenges of reading, humans are genetically programmed to speak; children are born with a neural structure to support spoken language acquisition (Norton & Wolf, 2012; Owens, 2012; Wolf, 2008). Consequently, typically developing children acquire speech and language without conscious effort, through exposure to language in their everyday environment. When children enter grade one, their spoken language skills are very similar to adults' and are used to support written language development (Nadler-Nir & Pascoe, 2016; Norton & Wolf, 2012; Stackhouse & Wells, 2002; Stuart, Stainthorp, & Snowling, 2008).

Humans are not genetically programmed to read and have no innate biological processes designed specifically for reading (Madonnet & Duffau, 2016; Nadler-Nir & Pascoe, 2016; Norton & Wolf, 2012; OECD, 2010; Taylor et al., 2015; Wolf, 2008; Wolf, 2010). Instead, "reading represents one of the marvels of the human brain's capacity to rearrange itself to learn something new" (Wolf, 2010, p. 184). Thus, literacy development requires explicit, formal instruction (Nadler-Nir & Pascoe, 2016; National Reading Panel, 2000; OECD, 2010). Children develop reading skills using brain areas evolved for other functions (Dehaene, 2010; Norton & Wolf, 2012; Taylor et al., 2015; Wolf, 2008; Wolf, 2010).

A large circuit of brain areas needs to be used to read fluently and with comprehension (Norton & Wolf, 2012; Wolf, 2008). The reading circuit uses cortical, subcortical and cerebellar neural systems responsible for language (phonology, morphology, syntax, semantics and pragmatics); visual processes; motor movements; working memory; attention; and cognition (Norris, 2013; Norton & Wolf, 2012; Reichle, 2015; Wolf, 2008; Wolf, 2010). Connections among these processes enable written words to be read. Some children have no difficulty with reading whereas others have difficulty because of environmental factors or physiological differences in the brain areas which support reading

(e.g., children with neurodevelopmental disorders or learning disabilities) (Nadler-Nir & Pascoe, 2016; Rose, 2006; Wolf, 2010).

Many frameworks, theories and models have been created to explain how children learn to read. These frameworks are helpful for understanding typical reading development and reading difficulties so that effective practices for reading instruction and intervention can be applied. A few important reading-related models will be described in the following sections.

1.4.2. Models of reading development.

1.4.2.1. Developmental models of reading development.

Many researchers have suggested that children pass through phases when learning to read and have formed theories about this progression. Four developmental models which have been particularly influential for SLTs working in the field of literacy will be reviewed: Frith's phase model, Ehri's phase model, Chall's stage model and Stackhouse and Wells' psycholinguistic framework.

Frith's (1985, 1986) model of literacy development proposes that there are three phases which a child transitions through when becoming literate: (1) the logographic phase, (2) the alphabetic phase, and (3) the orthographic phase. In the logographic phase, children learn to recognise words instantly based on striking graphic features (e.g. first letter, colour, font, size etc.). In the alphabetic phase, children learn how to produce the individual sounds of letters and blend the sounds together to form a word. In the orthographic phase, children learn how to recognise morphemic parts of words by considering letter order and the sound of morphemes or the whole word rather than of individual letters. According to Frith's model, reading delays or disorders occur when children have problems learning and mastering the skills in each phase. A limitation of Frith's model is that it does not adequately capture the full range of reading skills and distinctions demonstrated between children who have no alphabetic knowledge and those who are reading texts fluently (Beech, 2005).

Ehri (1995) and Ehri and McCormick (1998) drew heavily on Frith's model of reading development and extended it by proposing five phases in reading development: (1) the pre-alphabetic phase (words are identified based on their salient features rather than grapheme-phoneme (letter-sound) associations); (2) the partial alphabetic phase (children identify words with early letter knowledge and the visual appearance of the word); (3) the full alphabetic phase (children use their knowledge of most grapheme-phoneme units to read familiar and new words by blending the sounds together); (4) the consolidated alphabetic phase (children recognise many words by sight and they process common letter patterns as units when reading); and (5) the automatic alphabetic phase (children are fluent in automatically recognising familiar words and accurately decode unfamiliar words without conscious effort). Compared to Frith's model, Ehri's model is better able to capture the full spectrum of skills

demonstrated in children who are learning to read and children who read fluently and proficiently (Beech, 2005).

Frith's and Ehri's models do not consider how children read different types of texts at different stages, how schools provide different types of tasks at different stages and how the language and cognitive skills required to understand these texts differ in each stage. In contrast, Chall's (1979, 1983, 1996) six-stage model of reading development considers these factors.

In stage one of Chall's model, the emergent literacy period (birth to six years), children learn simple concepts related to reading and writing such as reading of signs, knowing the names of letters, writing their names and they may pretend to read books. In stage two (grade one and the beginning of grade two), children learn the alphabetic principle (the sounds associated with letters and how to sound out and recognise words). They learn that oral syntax rules apply to reading and writing. They read simple texts and learn to write basic words and sentences. In stage three (grades two and three), learners consolidate what they learned in the previous stages; their ability to access and use their knowledge becomes more automatic and fluent; they read many words by sight, write words and sentences; they begin reading multisyllabic words and words which have challenging orthographic and morphological patterns; and texts use language and ideas which are within the children's experience. In stage four (grades four to eight), there is a greater focus on understanding the meaning of what is read and written. Children begin to learn new vocabulary and information through reading and writing. They develop self-monitoring skills; they read texts which have more complicated syntactic structures than spoken sentences. Nonfiction text becomes important, and texts contain information outside of children's world knowledge. In stage five (grades eight to twelve), adolescents learn about multiple viewpoints and how to analyse and critique what they read. Critical thinking skills (such as reflecting on the writer's and one's own thoughts and making revisions while writing) are important. A deeper understanding of text structure develops and phase four skills are refined and consolidated. Finally, stage six represents adult tertiary education. In stage six, adults construct knowledge by reading and writing. They learn to read and write for different purposes. Critical thinking becomes increasingly important. Adults' vocabulary and language skills need to develop for them to comprehend and learn from texts at this level.

A strength of Chall's model is that it considers the relationship between children's oral language and literacy development. A model which makes the connection between spoken language and written language even more explicit is the psycholinguistic framework, proposed by Stackhouse and Wells (1997, 2002). The framework proposes that speech, phonological awareness (the ability to reflect on and manipulate the sound structure of an utterance) and literacy support one another and are all dependent on the speech processing system (which interprets spoken language). According to this model, a deficit in the child's speech processing system may result in speech, phonological awareness

and literacy difficulties. A subcomponent of their framework connects the phases of speech development with the phases of literacy development (based on Frith's model). It postulates that typically developing children move through the phases of speech development without difficulty and therefore acquire the skills required for phonological awareness and literacy to progress smoothly. However, children who have difficulties at one or more of the phases of speech development have speech problems which may, in turn, hinder phonological awareness and literacy development.

A limitation of developmental models is that they do not provide information related to the cognitive mechanisms which underlie word reading. Computational models of word reading offer such insights and will be discussed in the following section.

1.4.2.2. Computational models of word recognition.

Computational models of word reading offer explanations related to how words are recognised at cognitive and linguistic levels (Norris, 2013; Reichle, 2015; Taylor et al., 2015). These models use computer programmes to simulate the neural networks responsible for reading in typically developing children, children with developmental delay, children with brain injury and children with reading disorders such as dyslexia. There are many different categories of information processing models (Norris, 2013; Reichle, 2015; Taylor et al., 2015). Three influential branches of models include single route, dual route, and combined route models of reading words aloud (Norris, 2013).

A widely researched single route model of word reading is the connectionist triangle model (Hulme & Snowling, 2014; Norris, 2013; Seidenberg, 2005; Taylor et al., 2015; Yap & Liow, 2016). It proposes that there is a single mechanism for reading words whereby the orthographic input (written word) maps onto the phonological code (sound representation) for the word to be read (Frost, 1998; Lukatela & Turvey, 1994a, 1994b; Maris & de Graaf Stoffers, 2009; Van Orden & Goldinger, 1994; Van Orden, Pennington, & Stone, 1990). According to the model, words can be read through either the phonological route (orthographic representations are directly mapped onto phonology, i.e. the written word activates the pronunciation) or the (2) semantic route (the orthographic representation of the word maps onto the semantic representation which activates the phonological representation, i.e. the written word directly activates the meaning of the word which then activates its pronunciation) (Hulme & Snowling, 2014; Powell, Plaut, & Funnell, 2006; Taylor et al., 2015). Words can be read through either route but novel (unfamiliar) words and nonwords (pseudowords) are typically read by the phonological route, and irregularly spelled or exception words (which do not follow simple grapheme-phoneme correspondence rules) are usually read by the semantic route (Harm & Seidenberg, 1999; Plaut, McClelland, Seidenberg, Patterson, 1996; Powell et al., 2006; Seidenberg & McClelland, 1989; Taylor et al., 2015).

An influential dual-route model of word reading is the dual-route cascaded model (Carr, Davidson, & Hawkins, 1978; Coltheart & Rastle, 1994; Coltheart, 1978, 1980, 2006a, 2006b; Coltheart, Curtis, Atkins, & Haller, 1993; Kapnoula, Protopapas, Saunders, & Coltheart, 2017; Paap & Noel, 1991; Reichle, 2015; Taylor et al., 2015; Yap & Liow, 2016). According to this model, words are read aloud using two distinct procedures. To read a word by the lexical route, the orthographic input (written word) results in the corresponding entry in the orthographic lexicon (store of written representation of words) being selected, which activates the appropriate phonological output (the pronunciation of the word which the entry specifies) (Coltheart, 2006a; Kapnoula et al., 2017; Peterson, Pennington, & Olson, 2013; Reichle, 2015). The lexical route can process regularly spelled words (which follow grapheme-phoneme correspondence rules) and exception words, but it cannot read nonwords because these do not have orthographic lexical entries (as they have not been encountered before) (Coltheart, 2006a; Kapnoula et al., 2017; Reichle, 2015). To read a word by the nonlexical route, the orthographic input (written word) is sorted into graphemes, the graphemes are sorted into their corresponding phonemes according to a set of explicit rules and then the phonemes are assembled into a word for output. The nonlexical route can process regular words and nonwords but it cannot 'read' irregularly spelled words (because these do not follow grapheme-phoneme correspondence rules) (Coltheart, 2006a; Kapnoula et al., 2017; Reichle, 2015).

The connectionist dual processing model combines components of single and dual route models (Yap & Liow, 2016; Ziegler, Perry, & Zorzi, 2014). The model proposes that words are read by the output from two processes which occur simultaneously: a lexical process that connects orthography to phonology (the orthographic entry is directly linked with its phonological counterpart) and a nonlexical process which maps orthography to phonology via grapheme-phoneme correspondence rules (Perry, Ziegler, & Zorzi, 2007, 2010, 2013; Yap & Liow, 2016; Ziegler et al., 2014; Zorzi, 2010).

Computational models of word reading conceptualise word reading difficulties as being a result of a disruption to a process of word reading. If there is a breakdown in the phonological or nonlexical route, the child will have difficulty reading novel words and pseudowords - phonological dyslexia (Coltheart, 2006a; Peterson et al., 2013; Peterson, Pennington, Olson, & Wadsworth, 2014). If there is a breakdown in the semantic or lexical route, the child will have difficulty reading irregular words - surface dyslexia (Coltheart, 2006a; Peterson et al., 2013; Peterson et al., 2014).

Computational models have been criticised for failing to simulate accurate word reading skills in certain studies; however, most literature is supportive of their ability to represent the word reading skills of typically developing children, children with phonological dyslexia, and children with surface dyslexia with a fair degree of success (Coltheart, 2006a; Coltheart, 2006b; Kapnoula et al., 2017; Maris & de Graaf Stoffers, 2009; Norris, 1994; Norris, 2013; Perry et al., 2007, 2010, 2013; Peterson

et al., 2013; Peterson et al., 2014; Plaut et al., 1996; Powell et al., 2006; Seidenberg & McClelland, 1989; Yap & Liow, 2016; Ziegler et al., 2014; Zorzi, 2010; Zorzi, Houghton, & Butterworth, 1998). Nevertheless, a limitation of computational models of word reading is that they do not take into account the impact which understanding a word's meaning has in the reading process (Taylor et al., 2015).

1.4.2.3. The simple view of reading.

A framework which, unlike computational models, addresses the impact of understanding in the process of reading is the simple view of reading. The simple view of reading (Gough & Tunmer, 1986; Hoover & Gough, 1990; Hoover & Tunmer, 2018) is a static model which describes children's reading at a single point in time and proposes that reading comprehension (the ability to extract meaning from text) is the result of decoding (the ability to recognise words accurately and efficiently) and language comprehension (the ability to extract meaning from spoken language). A large body of evidence supports the framework and has shown that decoding skills and language comprehension capture the variance in children's reading comprehension (Catts, 2018; Hoover & Tunmer, 2018; Lonigan, Burgess, & Schatschneider, 2018; Rose, 2006).

The simple view of reading categorises children as typical readers (those who have good reading comprehension due to good decoding and language comprehension skills) and children with reading difficulties or disabilities. Children with reading disabilities are classified into one of three groups: (1) children who have poor decoding but good language comprehension – a decoding difficulty, (2) children who have good decoding but poor language comprehension – a reading comprehension difficulty, and (3) children who have poor decoding and poor language comprehension – a combined decoding and reading comprehension difficulty. Research over the last thirty years has found evidence to support each of these types of reading difficulties (Cain, 2010; Catts, 2018; Hoover & Tunmer, 2018; Lonigan et al., 2018; Nation, 2005; Rose, 2006). The simple view of reading is helpful for understanding the processes involved in reading comprehension, identifying and classifying children with reading difficulties, and for determining and providing appropriate reading intervention to children with reading difficulties. Due to its strengths, the simple view of reading will be used to interpret the results of the current study.

1.4.3.4. Dyslexia and the double-deficit hypothesis.

The current study investigated the effectiveness of an online reading intervention for children with reading difficulties. Understanding the types of reading difficulties which children present with was thus important. A term which is prevalent in the field of reading research is that of dyslexia. Dyslexia is a developmental, neurological disorder that occurs across a range of intellectual skills and presents

as a continuum of difficulty observed in decoding and spelling despite adequate learning opportunities (Elliott & Grigorenko, 2014; Lyon, Shaywitz, & Shaywitz, 2003; Norton, Beach, Gabrieli, 2015; Ozernov-Palchik, Yu, Wang, & Gaab, 2016; Alloway, Tewolde, Skipper, & Hjar, 2017; Rose, 2009; Wolf, 2010).

An influential framework for understanding dyslexia is the double deficit hypothesis, initially proposed by Wolf and Bowers (1999). The double deficit hypothesis claims that phonological deficits and naming speed deficits (the ability to name displays of letters, numbers, objects and colours rapidly) are two distinct sources of reading difficulty and when one occurs in isolation or they both occur together, dyslexia is the result. According to the framework, children with dyslexia can be categorised into the following subtypes: (1) those with phonological deficits who have poor phonological awareness skills, difficulty with decoding and reading comprehension fallout but no naming speed difficulties; (2) those with poor naming speed who have poor reading rate, poor reading fluency and reading comprehension fallout but no phonological difficulties; and (3) children who have double phonological and naming speed deficits who have difficulties in all areas of reading. The double deficit hypothesis has been supported by studies demonstrating that the three subtypes of reading difficulties exist in English and other languages such as German, Dutch, Finnish, Greek, Hebrew, Chinese and Japanese (Arujo & Faisca, 2019; Asadi & Shany, 2018; Frijters et al., 2011; Heikkilä, Torppa, Aro, Närhi, & Ahonen, 2016; Katzir, Kim, Wolf, Morris, & Lovett, 2008; Landerl & Wimmer, 2008; Lovett, Steinback, & Frijters, 2000; Manis, Doi, & Bhadha, 2000; O'Brien, Wolf, & Lovett, 2012; Song, Georgiou, Su, & Hua, 2016; Wolf & Bowers, 1999; Wolf & Bowers, 2000; Wolf et al., 2002; Wolf, 1999; Wolf, 2010).

A multi-deficit conceptualisation of dyslexia is widely supported in the literature and suggests that various combinations of weaknesses in cognitive skills such as working memory, verbal memory, auditory processing, language, phonological awareness and rapid automatized naming contribute to the difficulties underlying dyslexia (Catts, McIlraith, Bridges, & Nielson, 2017; Catts, Nielson, Bridges, Liu, & Bontempo, 2015; Fostick & Revah, 2018; Borleffs, Jap, Nasution, Zwarts, & Maassen, 2018; Ozernov-Palchik, Yu, Wang, & Gaab, 2016; Pennington et al., 2012; Pennington, 2006; Torgesen, 2000; Wolf, 2008). Although the present study did not focus specifically on dyslexia, the double-deficit hypothesis will be drawn on as needed when interpreting study findings.

1.4.3. Reading difficulties in South Africa.

The models discussed in this chapter have demonstrated that children may present with reading skills which are appropriate for their age and grade, delayed reading development or reading disorders. The section focusing on South Africa showed that a myriad of factors related to learners' reading performance exist such as the country's political history; socioeconomic issues; systemic problems;

and problems at the level of schools, teachers, parents and learners. The causes of disruption to reading skills are complex. The current study therefore uses the broad umbrella term “reading difficulty” to refer to one or more components of a child’s reading skills being below the level expected at the child’s age or grade, regardless of the cause of the difficulty.

The majority of typical South African children, through a combination of complex factors, will face reading challenges which may ultimately affect their life chances. There is an urgent need for large-scale, population-based intervention to target reading in South African schools. Although SLTs may have a key role in this process, they cannot meet the challenge alone or without employing innovative approaches to increase their reach.

1.5. Chapter Conclusion

The chapter provided the context for the reading intervention study. Research demonstrating the crisis in reading achievement in South Africa, the factors related to the crisis, and the historical background of education in South Africa were described. Information related to multilingualism, the importance of the language of learning and teaching and the role of the SLT in the education sector were explored. Finally, models for understanding typical reading development, word reading and reading difficulties were discussed. Chapter two will review literature related to information and communication technology (ICT) approaches to reading intervention. It will then describe the Virtual Reading Gym (VRG), the programme used in the intervention study.

Chapter Two

Information and Communication Technology-Based Reading Intervention

2.1. Introduction to Chapter

This chapter provides a literature review on the effectiveness of ICT-based reading intervention for improving children's reading skills. It then goes on to describe the VRG, the ICT-based reading intervention which was used in the current study. Background related to the VRG, VRG intervention targets, typical VRG intervention sessions, the evidence supporting the components of the VRG and previous VRG research studies are explored. The chapter concludes with a rationale for the study.

2.2. Reading Intervention

A large body of evidence has shown that reading intervention is effective in improving children's reading skills. Research investigating the effects of reading instruction and intervention for primary school children (grades R to seven) has found that targeting phoneme-grapheme knowledge and phonics, phonological awareness, fluency, vocabulary, comprehension and a combination of these components improves the reading skills of children with and without reading difficulties (Chard, Vaughn, & Tyler, 2002; Clarke, Snowling, Truelove, & Hulme, 2010; Edmonds et al., 2009; Flynn, Zheng, & Swanson, 2012; Galuschka, Ise, Krick, & Schulte-Körne, 2014; Gillon, 2017; McDonagh, 2017; Morris et al., 2010; National Reading Panel, 2000; Rose, 2006; Rowe, 2005; Scammacca, Roberts, Vaughn, Stuebing, 2015; Snowling & Stackhouse, 2006; Strickland, Boon, & Spencer, 2013; Suggate, 2010; Suggate, 2016; Therrien, 2004; Wanzek et al., 2013). Despite this knowledge, challenges exist in the field of reading instruction and intervention related to identifying and providing appropriate forms of support to children who have unique profiles of reading strengths and weaknesses as well as in reaching the large population of children needing reading support (Barratt et al., 2012; Gillon, 2017; Hatcher, 2006; Kathard & Moonsamy, 2015; Kathard & Pillay, 2013; Mdlalo et al., 2016; Moonsamy, 2015; Pascoe & Norman, 2011; Pascoe et al., 2018; Pascoe et al., 2013; Penn, 2002; Smit et al., 2006; Snowling & Stackhouse, 2006; Southwood & Van Dulm, 2015; van der Merwe & Le Roux, 2014). One approach of implementing reading support is through the use of ICT programmes.

2.3. Effectiveness of ICT-based Reading Intervention: A Literature Review

ICT approaches to reading intervention involve the use of electronic and digital tools such as computers, iPads, tablets, iPhones, smartphones, programmes, applications and the internet in the

delivery of reading intervention (Cheung & Slavin, 2013). ICT-based reading intervention has received the attention of practitioners and researchers due to its potential to improve reading skills through harnessing children's attention, engagement, motivation, feelings of autonomy and competence in learning as well as its capacity to be intensive (high instruction time), provide training which is individualised, to be at the appropriate level of difficulty and to offer immediate feedback (Kleinsz, Potocki, Ecalle, & Magnan, 2017; Mize, Bryant, & Bryant, 2019; National Reading Panel, 2000; Solheim, Frijters, Lundetræ, & Uppstad, 2018; van de Ven, de Leeuw, van Weerdenburg, & Steenbeek-Planting, 2017). The current study investigated an ICT-based reading intervention. Thus, an understanding of the outcomes associated with ICT-based reading interventions was essential.

A literature review on the effectiveness of ICT-based reading interventions for primary school learners was conducted. Key words were entered into the electronic databases of PsycArticles, PsychINFO, ERIC, Computers and Applied Sciences Complete, Academic Search Premier and CINAHL. Key words were entered in various combinations. The key words were *information and communication technology, computer-assisted instruction, computer, laptop, smartphone, iPhone, tablet, iPad, application, reading intervention, reading instruction, reading therapy, reading remedial, primary school, elementary school, middle school, junior school, children and learners*. Studies were included based on the following criteria: (a) publication in a peer-reviewed journal, (b) written in English, (c) published between 2008 and 2019, (d) experimental or quasi-experimental design used, (e) included learners in grades one to seven, (f) investigated one or more component of reading, and (g) intervention delivered via an electronic device. Interventions which investigated only spelling were excluded. However, interventions which investigated spelling and one or more component of reading were included. Systematic reviews and meta-analyses were excluded but their reference lists were consulted to find additional studies to include in the review. The findings of ICT-based systematic reviews and meta-analyses will be described later in this chapter (~2.3.3.).

The titles and abstracts of the generated lists of studies were checked and all studies which met the inclusion criteria were selected for review. A total of 31 articles met the criteria and were included in the review. Articles were published in a range of academic journals, mainly in the fields of education and psychology. Most of the studies were conducted in North America (17 studies), followed by European countries (12) and the fewest in African countries (2). None of the studies were conducted in South Africa. The papers included in the literature review are presented in Table 1 (Appendix A1).

The research design and participant characteristics of the papers in the review are displayed in Table 2 (Appendix A2). The designs employed in the studies varied. The sample included randomised control trials (8 studies), pre- and post-test designs (12 studies), multiple baseline across participant designs (9 studies) and alternating treatment designs (2 studies). The samples ranged in size from studies with between 1 and 10 participants (9), 15 and 90 participants (10), 100 and 200 participants (6), 250 to

360 participants (4), and studies with between 700 and 875 participants (2). Most studies (25) had between 1 and 200 participants. The foundation phase grades (one to three) were the most represented (21) and there were fewer samples which used children in the intermediate and senior phase (grades four to seven) (10). Of the studies which reported the sex of their participants, the majority (26) included both males and females, while a small number (2) included only males. Most of the studies had participants with identified reading difficulties (19), some had participants at risk of reading difficulties (5), a few had learners without specified reading difficulties from mainstream schools (5) and others included learners with language difficulties (2).

The intervention characteristics of the papers are shown in Table 3 (Appendix A3). A broad range of intervention programmes were included in the studies. Three of the studies investigated *ABRACADABRA* (*ABRA*), three investigated different language translations of *GraphoGame*, two used *Read 180* and two studied *Omega-Interactive Sentences* (*Omega-IS*) and *COMputerized PHOnological Training* (*COMPHOT*). The remaining 21 studies each investigated different ICT-based reading programmes.

ABRA is an online reading programme designed to improve phoneme-grapheme knowledge, phonics, phonemic awareness, word reading, fluency, vocabulary, listening comprehension and reading comprehension through structured games and activities (Abrami, Wade, Lysenko, Marsh, & Gioko, 2016; Concordia University, 2019; Flis, 2018; Lysenko & Abrami, 2014; Savage, Abrami, Hipps, & Deault, 2014). It has been designed to improve the reading skills of all learners in the early school years (generally grades R to two) and trained teachers are actively involved in instruction (Abrami et al., 2016; Flis, 2018; Lysenko & Abrami, 2014; Savage et al., 2014). *ABRA* is available in 27 different languages (Concordia University, 2019).

Read 180 is a mixed-methods English reading intervention (which includes teacher-delivered classroom instruction, teacher-delivered small group instruction, computer activities, and independent reading of levelled books) designed to improve phoneme-grapheme knowledge, phonics, phonological awareness, word reading, fluency, vocabulary and reading comprehension (Kim, Capotosto, Hartry, & Fitzgerald, 2011; Kim, Samson, Fitzgerald, & Hartry, 2010). *Read 180* has been designed to improve the reading skills of learners in the upper primary school and high school years (grades four to twelve) who have reading difficulties (Kim et al., 2011; Kim et al., 2010).

GraphoGame is an ICT-based reading intervention designed to improve phoneme-grapheme knowledge, phonics, phonological awareness and word reading through a sequence of structured game-based activities (Grapho Group, 2019). It was created for use with children in the early phases of literacy development (ages four to nine years) who are at risk of, or presenting with reading difficulties and is available in languages including English, French, Finnish, Norwegian, Dutch, and Chinese (Grapho Group, 2019; Kyle, Kujala, Richardson, Lyytinen, & Goswami, 2013; Saine,

Lerikkanen, Ahonen, Tolvanen, & Lyytinen, 2011; Solheim et al., 2018). Children use the programme independently on technological devices such as computers, tablets, iPads, smartphones and iPhones.

COMPHOT and *Omega-IS* are Swedish ICT-based reading programmes which can be used in conjunction with each other to improve the reading of learners with reading difficulties at an approximate grade two reading level (Fälth, Gustafson, Tjus, Heimann, & Svensson, 2013; Gustafson, Fälth, Svensson, Tjus, & Heimann, 2011). *COMPHOT* targets phoneme-grapheme knowledge, phonics, phonological awareness and word reading; *Omega-IS* targets word reading, sentence reading, vocabulary and reading comprehension (Fälth et al., 2013; Gustafson et al., 2011). A trained teacher or parent engages with the child while he/ she uses the programme (Fälth et al., 2013; Gustafson et al., 2011).

Most of the studies included in the review (25) investigated programmes which aimed to improve a combination of skills (two or more of the components of phonological awareness, phoneme-grapheme knowledge/ phonics, word reading, decoding, sentence reading, fluency, vocabulary, reading comprehension, spelling, writing and language skills). The remaining studies examined programmes which aimed to improve one component of reading, for example reading fluency (2), reading comprehension (2) and sight word reading (2). The technological devices used for intervention were predominantly computers (23), with the other studies using iPads/ tablets (6), iPods (1), and smartphones (1). The programmes frequently had adult facilitators involved in the delivery of the intervention (18), although learners accessed the ICT-based intervention independently in a number of studies as well (13).

In relation to intervention intensity, studies did not report on factors consistently. This meant only certain studies could be classified according to their intervention intensity variables. There were ten studies that reported on the total number of sessions, 24 studies that reported on the number of sessions per week, 28 on the amount of time per session, 23 on the number of weeks or months which intervention spanned, and nine which provided the total intervention time. The total number of sessions ranged from nine (2 studies), 16 to 18 (3 studies), 20 to 35 (4 studies) and 50 sessions (1 study). The number of intervention sessions per week ranged from one to four (2 studies), two to four (3 studies), three to five (2 studies), four (12 studies) and five (5 studies). Most of the sessions were 20 to 35 minutes in duration (10) and other session durations included three to 25 minutes (11), 40 to 60 minutes (6) and there was only one study which had sessions which lasted longer than 60 minutes. The total number of weeks which intervention covered varied considerably from two to five weeks (5), seven to 16 weeks (9), 23 to 25 weeks (3), 28 to 32 weeks (3), and 40 to 48 weeks (3). The total number of hours of intervention ranged from seven to 11 hours (6), 66 hours (1) and 80 to 88 hours (2). Clearly, components of intervention intensity varied considerably among the studies and a broad range of intensities were used.

Knowledge of optimal intervention intensity factors which produce the best outcomes is limited in the field of speech-language therapy (Baker, 2012). It is important for studies to report on all aspects of intervention intensity explicitly and clearly so that comparisons between studies can be made to accumulate knowledge in this insufficiently evidence-based area. Generated information can be used to guide the development and application of effective intervention intensity practices in reading and related domains.

Table 4 (Appendix A4) presents information related to the outcome measures and results of the studies included in the review. Standardised measures of reading skills were the mostly commonly employed outcome measures (20), about one third of the studies (9) used non-standardised measures and a small proportion (2) used both standardised and non-standardised measures. The vast majority of the studies included in the review (27/31 studies; 87.09 percent) reported positive treatment effects for one or more of their outcome measures. There were only four studies (12.90 percent) that reported no definitive positive effects associated with their intervention. Literacy skills which improved as a result of intervention included phonics and letter knowledge (2 studies), phonological awareness (6), word reading/ accuracy (14), decoding and pseudoword reading (9), fluency (10), vocabulary (3), comprehension (14) and spelling (8). The results of the literature review provide support for the conclusion that ICT-based reading interventions can be effective in improving primary school learners' reading skills.

2.3.1. Trends in studies with no intervention effect.

The researcher attempted to find trends in the characteristics of the four studies which did not report positive results to determine whether certain factors are related to ICT-based reading intervention success (El Zein et al., 2016; Given, Wasserman, Chari, Beattie, & Eden, 2008; Kim et al., 2010; Larabee, Burns, & McCormas, 2014). All four of the studies were conducted with English children in the United States (US) and had participants with identified reading difficulties. It seems unlikely that this trend is meaningful because most of the studies in the literature review were conducted in the US with English children who had reading difficulties. Each study had a different research design, investigated a different ICT-based reading programme and they had dissimilar sample sizes, resulting in no patterns emerging for these areas. Three of the studies had male and female participants and one of the studies had only male participants. Most studies in the review included both males and females, therefore this trend does not appear to suggest a sex-related impact on ICT-based reading intervention success. Three of the studies had adult facilitators during intervention and one reported that learners worked independently; this is much like the pattern in the entire sample of studies. One study aimed to improve a single reading skill, one study targeted two reading skills and the other two studies targeted more than three reading skills. This too is much like the pattern in the entire sample of studies included in the literature review. These factors aside, some potentially important patterns were

discovered. First, three of the studies used older participants (grades four to eight) and one used younger participants (grade one). This trend is potentially meaningful, as three of the ten studies with older participants (30 percent) reported null results, whereas only one of the studies with younger participants did (0.04 percent). Second, two of the studies used iPads and the other two used computers. There is a slight possibility that iPad instruction is an important variable as only six studies in the review used iPads and two of them failed to show positive results (33.33 percent), whereas only two of the 23 studies that made use of computers did not find significant results (0.08 percent). Third, half of the studies used informal outcome measures and the other half used standardised outcome measures. This indicates that 22.22 percent of the studies included in the literature review that employed informal outcome measures failed to find significant treatment effects whereas only 10 percent of the studies that used standardised outcome measures had null findings.

Next, the researcher calculated intervention intensity factors for the four studies that did not show positive results based on the figures provided in the papers. The intervention period ranged from two to 23 weeks of intervention and the sessions ranged from four to five sessions per week, similar to the bulk of studies in the review. The total number of sessions represented two studies with high intensity (60 sessions, 92 sessions) and two studies with low intensity (9 sessions, 16 sessions). The total number of hours of intervention represented two with low intensity (1 hour, 9 hours) and two with high intensity (88 hours, 92 hours). There was one study with a short session duration (7 minutes), one study with a moderate duration (35 minutes) and two studies with long session durations (60 minutes, 88 minutes). These trends may suggest that intervention is most effective in the medium intensity ranges.

In conclusion, it can tentatively be suggested that ICT-based reading interventions may not be as effective for older primary school learners (grades four to seven) as for younger learners (grades one to three), may not be as successful on iPads as computers, may be less likely to show treatment effects when informal outcome measures are used and may be the most beneficial to learners when it is delivered in the medium intensity ranges rather than low or high ranges. These patterns should be interpreted with caution because descriptive rather than inferential statistical methods were used. Furthermore, there were very few studies which reported null results and thus the trends may reflect a publication bias. Future research should investigate whether these trends are in fact meaningful. Chapter six (~6.5.) considers factors related to ICT programmes' success in more detail.

2.3.2. Publication bias.

It is possible that the results of the literature review are related to publication bias (i.e., the tendency for studies with null results not to be published) (Djulgovic & Guyatt, 2017). It is important for null results to be published in the literature so that intervention effects are not misrepresented (Ferguson & Heene, 2012; Franco, Malhotra, & Simonovits, 2014; Gage, Cook, & Reichow, 2017; Guan &

Vandekerckhove, 2016; Nissen, Magidson, Gross, & Bergstrom, 2016; Nosek, Spies & Motyl, 2012; Song, Hooper, & Loke, 2013). To estimate the possible impact which publication bias may have had on the literature review findings, the researcher searched for doctoral dissertations (the results of which had not been published in peer-reviewed journal articles) which were published between the years 2008 and 2019 and had investigated the impact of ICT-reading interventions for children in primary school. There were ten dissertations which met the criteria (Beaudry, 2014; Bush, 2014; Castillo, 2017; Falke, 2012; Flis, 2018; Schneider-Richardson, 2015; Seiler, 2015; Wilkinson, 2008; Worrell, 2011; Yancsurak, 2013). Most of these (7/10; 70 percent) reported statistically significant positive reading outcomes for learners associated with the ICT-based reading intervention (Castillo, 2017; Falke, 2012; Flis, 2018; Schneider-Richardson, 2015; Seiler, 2015; Worrell, 2011; Yancsurak, 2013). However, a fairly high proportion (4/10; 40 percent) did not report an intervention effect (Beaudry, 2014; Bush, 2014; Wilkinson, 2008). The proportion of dissertations with null findings (40 percent) is more than three times higher than that reported in the literature review of peer-reviewed published studies (12.90 percent). These results show that publication bias likely had an impact on the literature review findings and led to an overrepresentation of studies associated with positive ICT-based reading intervention outcomes. Nevertheless, the results of both the literature review and the review of unpublished work still provide evidence that reading interventions which make use of ICT approaches can improve children's reading skills.

2.3.3. ICT meta-analyses.

The National Reading Panel's (2000) review on ICT-based reading instruction analysed 21 studies. All reported positive results. The authors concluded that ICT-based programmes can be used to deliver successful reading intervention. Since the National Reading Panel's review, meta-analyses of ICT approaches to reading intervention have reported similar results. They have found moderate positive effect sizes of ICT-based reading intervention for middle school learners (grades six to eight) (Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2008); small positive effect sizes for ICT-based reading intervention for primary and high school learners (grade R to 12) (Cheung & Slavin, 2011); and small positive effect sizes for elementary school learners with reading difficulties (grades R to six) (Cheung & Slavin, 2013). Overall, research conducted in the last two decades suggests that ICT approaches to reading intervention can lead to gains in learners' reading skills.

2.3.4. Summary of ICT-based reading intervention.

The findings of the current literature review in combination with the results of meta-analyses indicate that ICT-based reading interventions hold promise for primary school children with reading difficulties. The next part of the chapter introduces the VRG, the ICT-based reading intervention which was investigated for the purposes of the current study.

2.4. The Virtual Reading Gym (VRG)

2.4.1. Background.

The VRG is an English intervention designed to improve children's reading skills and was developed by a South African SLT, Elizabeth Nadler-Nir (VRG, 2017). The VRG's online platform can be accessed on devices with internet connection and sound output such as desktop computers, laptops, tablets and iPads. Once registered, a child is given a username and password to access his or her personal online VRG account (Image 1⁹, Appendix A5) (VRG, 2017).

The VRG aims to develop the reading skills of children with reading difficulties, reading delays and reading disabilities. The programme is suitable for children who have skills at a grade two or higher reading level. Although created for grade two to seven primary school children, it can be used for older children and adults with literacy challenges because passages extend to a grade eight level (Nadler-Nir & Pascoe, 2016; VRG, 2017).

Children navigate the VRG activities with the help of a reading partner. A reading partner is an individual older than the child who has strong reading skills, leads the child through the intervention and provides support and feedback. Required reading partner characteristics are responsibility and commitment to supporting the child's reading development, reading skills superior to that of the child, and the ability to build positive rapport with the child. Therefore, the reading partner could be a therapist, teacher, remedial teacher, parent, volunteer, sibling, friend, or an older child (Nadler-Nir & Pascoe, 2016; VRG, 2017). Reading partners are equipped to provide intervention once they have watched a series of online videos which explain how to respond to errors, offer support, and promote active reading skills. While working through VRG activities with the child, on-screen written prompts appear to guide the reading partner's actions (VRG, 2017).

2.4.2. Comparison of VRG to other ICT-based reading programmes.

The VRG is designed for older struggling readers unlike *ABRA*, *GraphoGame*, *COMPHOT* and *Omega-IS* which were developed for younger primary school children. The VRG's target age group is closer to that of *Read 180*, which is for learners in grades four to twelve. However, unlike *Read 180*, the VRG is not a mixed-methods approach and therefore does not include additional forms of reading instruction (e.g., classroom instruction, small group instruction, independent reading of levelled books). Similar to *ABRA* and *GraphoGame*, the VRG has reward-based activities aimed to motivate and capture the interest and active engagement of children. The VRG targets phonics and word

⁹ Elizabeth Nadler-Nir, executive director of the VRG, provided verbal consent for screenshot images of the VRG programme to appear in this dissertation.

reading skills (like *ABRA*, *Read 180*, *GraphoGame*, *COMPHOT* and *Omega-IS*) as well as fluency and sentence/passage-level reading skills, vocabulary and comprehension (like *ABRA*, *Read 180* and *Omega-IS*). Similar to *Omega-IS*, the VRG does not target phonological awareness skills. However, *ABRA*, *GraphoGame*, *COMPHOT* and *Read 180* actively target phonological awareness. Children complete VRG tasks with the support of an experienced reader which makes the programme comparable to *ABRA*, *Read 180*, *COMPHOT* and *Omega-IS* which all require the presence and input of trained adults. In contrast to the five ICT-based reading programmes mentioned in this paragraph, the VRG intervention was designed by a South African SLT and passages were written by a South African author. Therefore, the VRG content may be more culturally and linguistically relevant for South African learners than that of other ICT-based programmes.

2.4.3. VRG assessment.

The VRG has an inbuilt assessment which children complete before they begin intervention. The level of the assessment is based on the child's grade and whether they rated themselves as having above average, average, below average or significantly below average reading skills when creating the profile for their account. The assessment consists of a passage (which the child reads aloud) followed by ten multiple choice comprehension questions. The reading partner starts and stops the timer, clicks on the words which the child reads in error and selects the child's answers to the comprehension questions. The assessment generates reading accuracy, speed, and comprehension scores. Based on performance in the assessment, the programme selects the appropriate level for the child's intervention to begin.

2.4.4. VRG levels.

The VRG has eight graded levels based on text and comprehension question difficulty. Each consecutive level contains longer passages (a greater number of sentences and paragraphs per passage) as well as passages with longer sentences, more complicated sentence constructions and grammar, more challenging vocabulary, and more difficult comprehension questions than the preceding level. The VRG uses graded passages of narrative, expository, procedural, and descriptive nonfiction texts (Nadler-Nir & Pascoe, 2016). All texts were written for the programme by the South African writer Margaret Lewis. Children and their reading partners therefore read through a series of passages which gradually get more challenging. Each passage comes with an accompanying set of questions. The VRG assessment ensures that treatment begins at the appropriate level of difficulty for the child; one where there is a suitable balance of reading accuracy, rate and comprehension (Nadler-Nir & Pascoe, 2016; VRG, 2017).

2.4.5. VRG intervention targets.

The VRG intervention focuses on improving reading accuracy, rate, vocabulary and comprehension (Nadler-Nir & Pascoe, 2016; VRG, 2017). It aims to improve these skills in the following way: (1) accuracy – mispronounced or misread words are targeted at the syllable and phonics level, children are provided with a model of how to pronounce the word and related phonic word lists are read; (2) rate – repeated oral reading of texts occurs, each reading of the text is timed and texts can be reread up to three times; (3) vocabulary – the understanding and use of target words are trained based on syllable structure, orthography (spelling), semantics (word meaning) and syntax (use of the word in a sentence) and readers are encouraged to discuss and define word meanings before, during and after passages are read; and (4) comprehension – three types of questions are included after each passage – one related to main idea, one based on vocabulary (the meaning of a specific word) and one inferential question (Nadler-Nir & Pascoe, 2016; VRG, 2017).

2.4.6. VRG motivation.

VRG intervention is designed to be motivating for children (Nadler-Nir & Pascoe, 2016; VRG, 2017). The programme has an environmental theme which includes an inbuilt reward system. Children begin the programme with a polluted city (Image 2, Appendix A5). As children complete reading activities and tasks, they receive points (represented by leaves) (Image 3, Appendix 5) (VRG, 2017). Once they have a full gauge of leaves, a change occurs in the city (e.g., pollution is reduced; plants, animals and people are added; traffic diminishes; the natural scenery improves; the buildings change) (Image 4, Appendix A6) (VRG, 2017). As children read more passages, the city progresses through stages represented by different seeds, and the city becomes cleaner and more beautiful (Images 5 and 6, Appendix A6; Images 7 to 9, Appendix A7; Image 10, Appendix A8) (VRG, 2017). A further motivating factor built into the programme is that, at the beginning of intervention, children select a reading companion (a cat, dog or bird) (Image 11, Appendix A8) (VRG, 2017). The reading companion is present on the screen as the child completes tasks and it performs various movements (e.g. dances) and gets rewards (e.g. medals, trophies) when the child succeeds at activities.

2.4.7. A tour through a typical VRG intervention session.

According to the VRG website (www.virtualreadinggym.co.za), a typical 25-minute intervention session should consist of: reading a passage two to three times, answering the comprehension questions, completing the exercises in the pattern card box (phonics activities) and completing the exercises in the vocabulary card box (vocabulary activities). This section will thus provide an overview of all the tasks that would typically be completed in a single intervention session and provide photographs from the VRG programme to illustrate each step. The steps have not been described on the VRG website or in other documents which contain information related to the VRG.

Therefore, the researcher developed the list of steps by exploring a VRG account created for the purposes of the study, and with permission from the VRG (Elizabeth Nadler-Nir, personal communication).

2.4.7.1. Step 1: Begin reading a passage.

The reading partner clicks on the text which says “click here to start reading” on the left of the city, which opens a new passage (Image 12, Appendix A8). The child is instructed to read aloud to understand the passage and the reading partner is requested to press “start” to begin the timer, press “pause” to discuss the passage while it is being read, click on words which the child reads in error, and press “stop” when the child has finished reading the whole passage (Images 13 and 14, Appendix A9). As the child is reading, the reading partner provides a model of how to pronounce each word the child reads in error.

2.4.7.2. Step 2: Understand the meaning of key words in the passage.

Certain key words in the passage are displayed in bold print (Image 15, Appendix A9). The reading partner asks the child whether he or she knows the meaning of each bold word. Bold words which the child does not understand are clicked on by the reading partner, which results in the syllables and definition of the word appearing (Image 16, Appendix A10). The meaning of the word may be discussed with the child. All words which are clicked on in this phase are stored in the child’s vocabulary pattern box.

2.4.7.3. Step 3: View performance.

A grid appears which contains information related to the child’s reading performance during the passage (the number of errors which were produced and the child’s reading speed) (Image 17, Appendix A10). The results may be discussed with the child and goals set for the subsequent read (e.g., reading speed and accuracy rate to aim for). Each time the child reads the passage, a row containing the new performance information is added and the reading partner has the option of displaying a visual representation of each read (Image 18, Appendix A10). This allows the reading partner and child to determine whether the goals were achieved and positive reinforcement/encouragement related to improvements to be given.

2.4.7.4. Step 4: Practice error words.

A list of all the words the child read incorrectly in the passage is displayed (Image 19, Appendix A11). The child reads through the full set of words with the help of the reading partner. Next, one of the words is selected for further practice.

2.4.7.5. Step 5: Practice a specific error word.

The word selected for further practice is displayed in syllables and as a complete word. The child segments the word into syllables and then reads the word. Challenging patterns (phoneme-grapheme correspondences or morphemic units) within the word are presented. The child reads each pattern in isolation and then a list of words which contain the same pattern (Image 20, Appendix A11). The reading partner clicks on patterns with which the child has difficulty so that they are stored for later practice. The stored patterns are saved in the pattern cards box.

2.4.7.6. Step 6: Repetition of steps 4 & 5.

The list of words which the child read incorrectly in the passage will appear, except the word which was practiced in-depth will not be displayed. The child reads through the full list of words with the help of the reading partner and then selects a second word to practice in depth. Once the word is selected, the same activity as step five will occur for the newly selected word.

2.4.7.7. Step 7: Repetition of steps 1 & 3 to 6.

The same passage is read for a second time. The same sequence of subsequent steps one to six is followed (except that step two does not occur).

2.4.7.8. Step 8: Repetition of steps 1 & 3 to 6.

The reading partner is given the option to select a third reading of the passage or to skip to step nine. If the child reads the passage for a third time, the same procedure as described in steps one to six is followed (although, again step two does not occur).

2.4.7.9. Step 9: Answer the reading comprehension questions.

Three questions related to the passage are presented. Each question is followed by a set of three multiple choice answers to choose from. The reading partner or the child reads the questions and answers aloud. The first question is related to the main idea of the passage (Image 21, Appendix A11); the second question is related to the meaning of a specific word in the passage (Image 22, Appendix A12) and the third question is inference-based (Image 23, Appendix A12). The reading partner clicks on the answer which the child indicates. The accuracy of the answer is displayed by the programme (Image 24, Appendix A12).

2.4.7.10. Step 10: Pattern cards.

The pattern card and vocabulary card boxes appear (Image 25, Appendix A13). The reading partner clicks on the pattern card box. Cards contain the patterns saved from step five as well as any patterns the reading partner has added to the child's box (Image 26, Appendix A13). Patterns include long

vowels, short vowels, vowel digraphs, r-controlled vowels, diphthongs, consonant blends, consonant digraphs, prefixes, and suffixes. Each card targets a specific pattern. For each card, the child reads the pattern in isolation and in a word (Image 27, Appendix A13). The reading partner clicks on “yes” if the child reads correctly and “no” if the child does not. If “yes” is clicked, the child begins with the next card. If “no” is clicked, the child listens to the programme’s audio reading of the pattern and sound or the reading partner can model the correct response. The child then attempts the pattern and word for a second time. The reading partner selects the button which says “click here if you need more practice” if necessary. If selected, a grid of eight words appears which contain the same pattern with which the child struggled (Image 28, Appendix A14). The reading partner clicks “start” to begin the timer and the child reads the words from left to right. The reading partner clicks on the words the child reads in error and provides a model of how the word should be read. Once the child has finished reading the grid, the reading partner presses “stop”. The time which it took the child to read the grid appears (Image 29, Appendix A14). If the child made errors, he/ she will read the grid for a second time before going on to the next card in the box. If the child made no errors, he/ she continues to the next card in the box. The process continues until there are no more cards in the box.

2.4.7.11. Step 11: Vocabulary cards.

The pattern card and vocabulary card boxes appear. The reading partner clicks on the vocabulary card box (Image 30, Appendix A14). Cards contain the words saved from step two. Each word is practiced in three different activities: (1) match the definition to the word – the reading partner or the child reads the definition and the three multiple choice options, the reading partner selects the word the child indicates and the programme indicates the accuracy of the response (Image 31, Appendix A15); (2) fill in the missing letters – the beginning of the word appears and the child types in the remaining letters to spell the word and the programme indicates the accuracy of the response (if the child spelled the word incorrectly he/ she has a second chance to type in the correct letters) (Image 32, Appendix A15); and (3) select the missing word – the reading partner or the child reads the sentence which has a missing word and the three multiple choice options, the reading partner selects the word the child indicates, and the accuracy of the child’s response is displayed (Image 33, Appendix A15). The process continues until there are no more vocabulary cards in the box.

2.4.8. Support for VRG activities.

The VRG was analysed and a list of the explicit core components and constructs of the programme (aims and activities) was created. To determine the theoretical and scientific basis of the programme, the researcher completed a literature search of peer-reviewed research conducted between 2000 and 2019 which contained theory and evidence which support the use of the VRG components for literacy instruction and intervention. This information is presented in Table 5.

Table 5: Research literature supporting VRG aims and activities

VRG aims and activities	Supporting evidence from research literature
Rewards and motivators: reading partner present for feedback and support, animated on-screen reading companion character, leaves (points), changes to the city, progressing through different seeds (levels) as passages are read.	Clark & Douglas, 2011; Clark & Foster, 2005; Clark, 2014; Gambrell, 2011; Guthrie & Wigfield, 2000; Guthrie et al 2004; Guthrie et al., 2006; McGeown et al., 2015; Morgan & Fuchs, 2007; Mullis et al., 2017; Ronimus, Kujala, Tolvanen, & Lyytinen, 2014; Schiefele, Schaffner, Möller, & Wigfield, 2012; Segal-Drori, Korat, Shamir, & Klein, 2010.
Immediate feedback related to accuracy of performance.	Armbruster, 2010; Chard et al., 2002; Eckert, Dunn, & Ardoin, 2006; Lee & Yoon, 2017; Magno, 2010; National Reading Panel, 2000; Stevens, Walker, & Vaughn, 2017; Strickland et al., 2013; Therrien, 2004.
Passage difficulty matched to child's reading abilities.	Burns & Roe, 2010; Armbruster, 2010.
Repeated reading of passages, child receives model of how to read error words, child views reading accuracy and rate performance, goals for subsequent reads are made.	Chard et al., 2002; Hudson, Lane, & Pullen, 2005; Armbruster, 2010; Lee & Yoon, 2017; National Reading Panel, 2000; Stevens et al., 2017; Strickland et al., 2013; Therrien, 2004.
Repeated reading of child's own error words.	Wolf & Katzir-Cohen, 2001.
Practice of child's own error words at syllable and sound level.	Bhattacharya & Ehri, 2004; Diliberto, Beattie, Flowers, & Algozzine, 2008; Ecalle, Magnan, & Calmus, 2009; Ecalle, Kleinsz, & Magnan, 2013; Toste, Capin, Williams, Cho, & Vaughn, 2019.
Comprehension questions: main idea, vocabulary and inference.	Burke, Fiene, Young, & Meyer, 2008; Connor, Morrison, & Petrella, 2004; Nation & Angell, 2006; National Reading Panel, 2000; Scharlach, 2008; Wolf et al., 2009; Zimmerman & Hutchins, 2003.
Patterns in box based on child's own phonic difficulties.	Rose, 2006.
Phonics: patterns trained in isolation and words.	Armbruster, 2010; Morris et al., 2010; Rose, 2006; Rowe, 2005; Wolf, 2010; Wolf, Miller, & Donnelly, 2000; Wolf et al., 2003.
Phonics and fluency: eight words (containing pattern child struggles with) read to a timer.	Wolf, 2010; Wolf, et al., 2000; Wolf et al., 2003; Toste et al., 2019.
Vocabulary: syllables and definition of words.	Armbruster, 2010; Bhattacharya & Ehri, 2004; Graves, 2016; National Reading Panel, 2000; Taylor et al., 2015.
Vocabulary: match to definition (semantics), fill in missing word (syntax), type in missing part of word (orthography).	Armbruster, 2010; Graves, 2016; Morris et al., 2010; National Reading Panel, 2000; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009; Stackhouse and Wells, 2002; Taylor et al., 2015; Wolf et al., 2009; Wolf, 2008.

Table 5 demonstrates that there is scientific literature which supports the use of the elements of the VRG programme for literacy instruction and intervention. Consequently, there is broad theoretical evidence to suggest that the VRG intervention has the potential to improve children's reading skills.

2.4.9. Previous VRG research.

Three case studies (Pascoe, Nadler-Nir, Le Roux & Patterson, 2017) found positive gains in learners with reading difficulties' reading accuracy, rate, vocabulary and comprehension following VRG intervention. Additionally, a larger-scale study which made use of a group design was conducted in 2017 to evaluate the efficacy of the VRG intervention (Pascoe et al., in preparation). The study investigated the effects of the intervention for learners from mainstream schools and made use of peer reading partners. A sample of 93 learners was used and learners were randomly assigned to the VRG intervention or a control condition. Intervention was found to have no effect when control and treatment groups were compared, possibly related to study design and implementation issues. The authors recommended that future research should use a small sample of the original data to complete a more fine-grained analysis of individual learners so that factors related to VRG efficacy could be better understood. Moreover, the authors hypothesised that the VRG may be more effective with adult reading partners than peer reading partners and that it may be more beneficial to learners with more marked reading difficulties than the children who participated in that study who were in mainstream schools.

2.5. Rationale for Study

Research which seeks to discover practical solutions for the South African reading crisis is paramount. The VRG is a locally designed ICT-based reading programme which makes use of reading partners and has been developed for South African learners with reading difficulties. There is a paucity of research which has explored the potential benefit of ICT-based reading intervention in South Africa. In particular, there are limited studies which have examined the impact of ICT-based reading intervention for learners in the higher primary school grades. The current study contributed by investigating the effectiveness of the VRG for grade three to six learners with reading difficulties. The research set out to add to the national and international evidence base for ICT approaches to reading intervention.

The VRG's online platform makes it accessible in all areas which have internet and technology, and a broad range of reading partners could be trained to provide the VRG support. These factors lend the VRG to a population-centred approach to service delivery so that the large number of children in need of reading support could be reached (Acker & Klop, 2015; Kathard & Moonsamy, 2015; Kathard et al., 2011; Moonsamy, 2015; Nadler-Nir & Pascoe, 2016; Wium & Louw, 2013). Studying the VRG with South African learners is thus an important pursuit.

In light of the recommendations by Pascoe et al. (2017) and Pascoe et al. (in preparation), the current study investigated the effects of the VRG intervention for learners from mainstream schools and a school for LSEN. The retrospective analysis extended the 2017 VRG study by using a sample of the original data and a new approach (a matched subject design) to complete a fine-grained analysis to better understand the programme. Additionally, the prospective study explored the hypotheses put forward by Pascoe et al. by using adult (SLT) reading partners and children with reading difficulties from a school for LSEN. No previous studies had investigated the effectiveness of the VRG for children with special educational needs and made use of SLT reading partners. Finally, the qualitative inquiry of the prospective study set out to obtain much-needed insight about learners' attitudes towards the VRG, important for understanding the impact of motivation on reading performance (Clark, 2014; McGeown et al., 2015; Mullis et al., 2017; OECD, 2010; Petscher, 2010; Schiefele et al., 2012).

2.6. Chapter Conclusion

The chapter presented a literature review on the effectiveness of ICT-based reading intervention for improving children's reading skills. Trends in studies with no treatment effects were explored and the possibility of publication bias being implicated in the literature review findings was considered. The VRG was described in terms of its background, intervention targets, activities completed within a typical session and evidence supporting the components of the VRG. Findings of previous VRG studies were outlined. Finally, the chapter concluded with a rationale for the current study. Chapter three details the methodology of the study.

Chapter 3

Methodology

3.1. Introduction to Chapter

This chapter details the methodology of the study, which comprised two parts: a retrospective analysis and a prospective study. Both components focused on evaluating effectiveness of the VRG but in two different contexts: the retrospective analysis investigated the use of the programme in mainstream schools and the prospective study explored its use in an LSEN school. Both studies used reading partners to support learners during intervention but two different approaches were used: the retrospective analysis examined the use of peer reading mentors while the prospective study made use of SLT reading partners.

3.2. Retrospective Analysis

3.2.1. Introduction to Retrospective Analysis

In 2017, Dr Michelle Pascoe in consultation with Elizabeth Nadler-Nir conducted a randomised control trial which aimed to evaluate the effectiveness of the VRG online intervention for children with reading difficulties. Participants were recruited from five mainstream schools in Cape Town. Participants (n=93) with reading difficulties from grades three to six were randomly assigned to control and intervention groups. Participants were assessed using a range of measures of reading and vocabulary pre- and post-intervention. Trained volunteer learners who had average or above average reading skills for their grade participated as peer reading partners to deliver the VRG intervention to the struggling readers. Intervention was provided three times per week for 20 to 30 minutes per session for a total of ten weeks. The study generated a large dataset and work is in progress to publish the outcomes (Pascoe et al., 2017; Pascoe et al., in preparation). Preliminary analysis of intervention and control group data suggests no significant differences between the groups on the primary outcome measures.

The researcher did not conduct and was not involved in the collection of data for the 2017 study. However, given the large amount of data arising from that study, the first part of the current study involved a small subset of data from the 2017 dataset, which is referred to as the “retrospective analysis” in this project. The focus was on a smaller set of children using retrospective matched pairs. Randomised control trials have been referred to as the “gold standard” of research designs but their usefulness in evaluating complex interventions has been criticised (Deaton & Cartwright, 2018; Pring, 2004; Sanson-Fisher, Bonevski, Green, & D’Este, 2007). Randomised control trials provide an average treatment effect by using group means but they cannot capture the smaller changes which

may be observed at an individual level (Deaton & Cartwright, 2018). Other research designs can be better suited to showing that interventions have resulted in meaningful statistical and clinical changes, and smaller sample sizes, although reduced in statistical power may allow for deeper understanding of why (and how) an intervention works to bring about changes (or not) (Pring, 2004; Sanson-Fisher et al., 2007). This kind of information is important for early-stage evaluations of interventions. For these reasons, a smaller subset of data was focused on to look in greater details at individual children and their reading/language profiles over the course of intervention. The use of a matched subject design with a small sample of the 2017 study data was carried out to increase statistical power to detect intervention effects, promote equivalence between intervention and control groups, determine whether more intervention than control learners improved, gain in-depth understanding of the impact of VRG intervention, and to guide subsequent research into the programme (Djulbegovic & Guyatt, 2017; Pring, 2004; Sanson-Fisher et al., 2007; Shadish, Cook, & Campbell, 2002).

3.2.2. Research Question

The research question was: Does VRG intervention improve the reading skills of mainstream grade three to six learners with reading difficulties when the programme is delivered by peer reading mentors?

3.2.3. Aim

The aim was to determine the effectiveness of peer-delivered VRG intervention for grade three to six learners with reading difficulties from mainstream schools.

3.2.4. Objective

The objective was to describe changes in learners' reading (accuracy, rate, vocabulary and comprehension) after VRG intervention.

3.2.5. Research Design

A matched subjects design was used (Shadish et al., 2002; Treat, 2013; Tredoux & Smith, 2006; Wren & Roulstone, 2008).

3.2.6. Participants

3.2.6.1. Randomisation.

For the 2017 study, participants were randomly assigned to either the control or intervention condition. Learners in the intervention condition received VRG intervention three times per week (20 to 30 minutes per session) for ten weeks. Those in the control condition continued as normal with regular school activities.

3.2.6.2. Participant description.

Raw data from grade three to six learners who participated in the VRG study in 2017 was used for the retrospective analysis. The learners had teacher-identified reading difficulties and attended mainstream schools in Cape Town. The original study took place in five schools, yet the retrospective analysis only had participants represented from four of the schools. This was because participants' pre-test data was too dissimilar to match participants into pairs according to the determined matching criteria. A total of 20 participants' data was used for the sample. The sample consisted of 8 males and 12 females. The following grades were represented: four learners from grade three, three learners from grade four, 11 learners from grade five and two learners from grade six. The average age of the learners at pre-test was 10 years 0 months. Information related to participant characteristics is displayed in Table 6.

Table 6: Overview of participants for the retrospective analysis

Group n=20	School Code				Grade				Age at pre-test (M)	Sex	
	AA	AB	AC	AD	3	4	5	6		Male	Female
Intervention	1	5	1	3	3	1	6	0	9; 7	3	7
Control	1	5	1	3	1	2	5	2	10; 4	5	5

3.2.6.3. Participant inclusion criteria.

Schools which participated in the 2017 study met the following criteria:

- (a) English as the language of learning and teaching or English as one of the languages of instruction in a dual medium school. This criterion was necessary as the VRG is an English reading programme.
- (b) Access to computers with internet and sound output. This criterion was needed because the VRG is an online programme with audio output.
- (c) School, parental and learner willingness for participants to be excused from non-core academic activities or to attend intervention half an hour before or after the school day. This criterion was essential so that learners received the VRG intervention at school but did not miss valuable teaching and classroom time.

The learners with reading difficulties had:

- (a) A teacher-identified grade two or higher reading level because the VRG requires learners to have grade two reading skills or higher.

- (b) Difficulties with reading (in one or more component of rate, accuracy, vocabulary and comprehension) compared to grade level because the VRG is designed to improve struggling readers' skills.
- (c) Functional English skills (defined as the ability to understand, speak, learn and read in English even if English was not a home language) as the VRG is an English reading programme.
- (d) Typical vision so that average sized text (font 14) on a computer screen could be seen, as this is the format of the VRG.
- (e) Hearing within normal limits so that hearing did not impact the ability to listen to the reading partners' speech and the VRG audio output.
- (f) Adequate attention, behaviour and cooperation for working at a computer screen with a reading partner for intervals of twenty to thirty minutes.

Information related to (c) to (e) was obtained by the researchers of the 2017 VRG study who accessed and reviewed the learners' school folders. Parental consent and learner assent were provided for the access and review.

The peer reading partners were/had:

- (a) A teacher-identified average or above average reading level for their grade.
- (b) Two or more years older than the child with reading difficulties.
- (c) Functional English skills (defined as the ability to understand, speak, learn and read in English even if English was not a home language).
- (d) Typical vision.
- (e) Hearing within normal limits.
- (f) A teacher- and self-identified interest and commitment to working with a struggling reader for a school term.

3.2.6.4. Participant exclusion criteria.

The exclusion criterion for the learners with reading difficulties was:

- (a) Being involved in one-on-one or small group reading intervention at school or outside of school. This was important because additional intervention could have confounded the study results. Learners who had received reading intervention in the past or who were on a waiting list to receive reading intervention in the future were eligible for inclusion in the study.

There were no exclusion criteria for the schools or peer reading partners.

3.2.6.5. Sample size.

The data from 20 participants (10 pairs) was used as the sample for the retrospective analysis. The sample represented data from 10 participants assigned to the intervention group and 10 assigned to the control group (as each pair contained one participant from each group).

3.2.6.6. Sampling and matching.

In the original study the learners were randomly assigned to either the control or intervention condition. However, the learners were not matched. For the current study, the data was used to create matched pairs. Pairs were formed by matching a learner from the intervention condition with a learner from the control condition. Post-intervention results were not made available during the matching procedure. Five criteria were used to match the participants. These criteria were: (1) school (each learner in the pair must have been at the same school) and learners' pre-intervention reading ability measured by standardised scores on the Wechsler Individual Achievement Test – second edition (WIAT-II) subtests of (2) word reading, (3) pseudoword decoding, (4) reading comprehension and (5) pre-intervention receptive vocabulary as measured by standardised scores on the British Picture Vocabulary Scale (BPVS).

Participants were matched by school to control for variables such as teacher qualification level, quality of reading instruction, opportunities for reading, and socio-economic status of the learners as these factors are relatively consistent within a single South African school but are different across schools (Spaul, 2013b). Moreover, these specific areas have been shown to have an impact on learners' literacy levels (Kathard & Moonsamy, 2015; Modisaotsile, 2012; Spaul, 2013b; van Staden & Bosker, 2014). Participants were matched on word reading, pseudo-word decoding, reading comprehension and receptive vocabulary because studies have shown that these skills are strongly related to children's broader reading abilities (Biemiller, 2003; Catts, 2018; Graves, 2016; Haarbauer-Krupa, 2008; Hoover & Tunmer, 2018; Kirby et al., 2012; Lonigan et al., 2018; Macchi, Schelstraete, & Casalis, 2014; Ouellette & Beers, 2010; Qian, 2002; Wise, Sevcik, Morris, Lovett, & Wolf, 2007).

Caliper matching was used, as an established range of scores guided the formation of the pairs (Becker, 2018; Lunt, 2014). The sample of 93 participants' data was used to form participant pairs (Figure 1) based on the following criteria: (a) one learner in the pair was in the intervention group and the other in the control group; (b) the two learners went to the same school; (c) the two learners' scores differed by a maximum of seven standard score points on pre-test measures of word reading, pseudoword decoding, reading comprehension and receptive vocabulary; and (d) the sum of the differences between the two learners' pre-test scores for the four measures was a maximum of 15 standard score points.

Table 7 shows participant characteristics and the fulfilment of the matching criteria for the participant pairs. The criteria enabled a total of ten participant pairs to be formed. Thus, the data from 20 participants was the sample for the retrospective study (Figure 1). The mean (M) differences in scores between the formed pairs were as follows: WIAT-II word reading subtest ($M=2.8$), WIAT-II pseudoword decoding subtest ($M=4.1$), WIAT-II reading comprehension subtest ($M=3.1$), BPVS ($M=2.3$) and sum difference of the four measures ($M=12.3$).

The primary supervisor reviewed the matches to check whether the pairs accurately reflected the data and to determine whether the best possible matches (learners with the closest scores) had been paired. There were no discrepancies between the researcher’s and supervisor’s pairs.

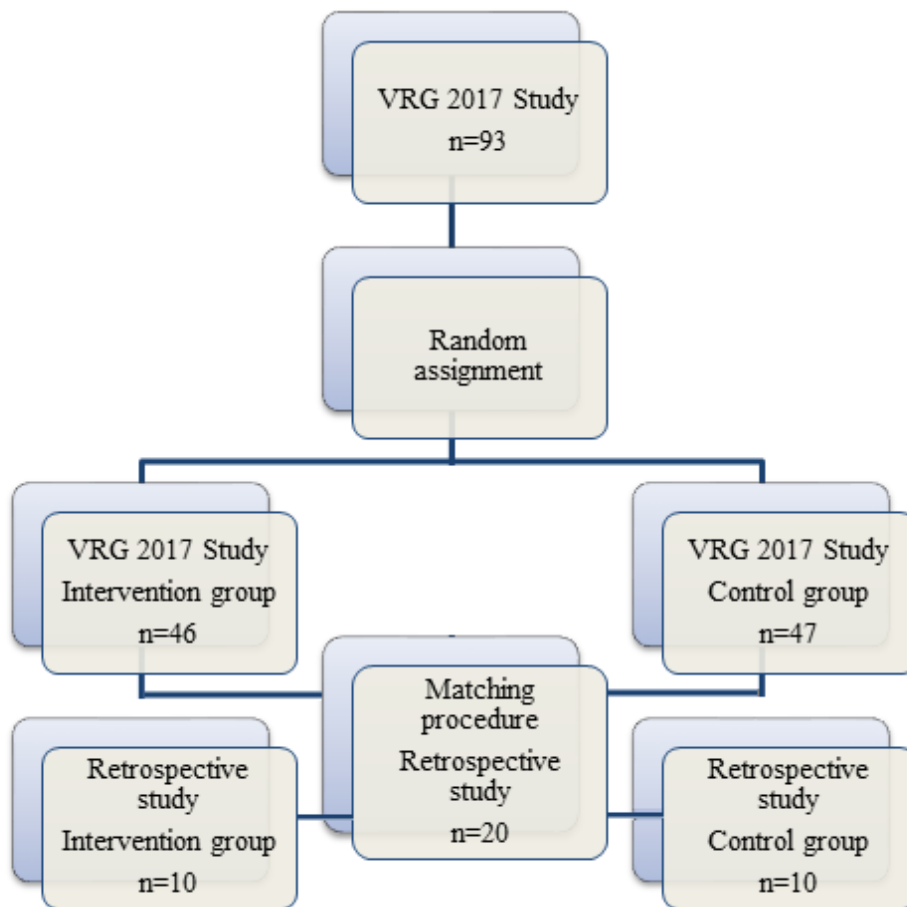


Figure 1: Retrospective analysis sampling procedure

Table 7: Retrospective analysis participant characteristics and pre-test standard scores on matching outcome measures

Matched pair	Randomisation	School code	Grade	Sex	WIAT-II word reading	WIAT-II pseudoword decoding	WIAT-II reading comprehension	BPVS	Total score difference
Participant A Participant B <i>Score difference</i>	Intervention Control	AA AA	3 3	F F	72 76 4	75 82 7	76 77 1	99 101 2	14
Participant C Participant D <i>Score difference</i>	Intervention Control	AB AB	3 6	M F	102 99 3	90 96 6	109 112 3	86 87 1	13
Participant E Participant F <i>Score difference</i>	Intervention Control	AB AB	5 4	M F	97 93 4	107 103 4	98 97 1	95 101 6	15
Participant G Participant H <i>Score difference</i>	Intervention Control	AB AB	4 5	F F	97 95 2	95 92 3	103 102 1	100 102 2	8
Participant I Participant J <i>Score difference</i>	Intervention Control	AB AB	5 5	F M	84 87 3	94 88 6	113 114 1	105 105 0	10
Participant K Participant L <i>Score difference</i>	Intervention Control	AB AB	5 6	M M	96 102 6	94 99 5	97 96 1	99 98 1	13
Participant M Participant N <i>Score difference</i>	Intervention Control	AC AC	3 4	F F	87 87 0	90 92 2	96 103 7	101 99 2	11
Participant O Participant P <i>Score difference</i>	Intervention Control	AD AD	5 5	F M	92 93 1	95 98 3	77 71 6	52 57 5	15
Participant Q Participant R <i>Score difference</i>	Intervention Control	AD AD	5 5	F F	91 92 1	95 94 1	92 88 4	90 87 3	9
Participant S Participant T <i>Score difference</i>	Intervention Control	AD AD	5 5	M M	91 95 4	99 103 4	89 95 6	82 83 1	15
Mean score difference					2.8	4.1	3.1	2.3	12.3

Note. M refers to male. F refers to female.

3.2.7. Materials and Measures

A battery of standardised and informal assessments (Appendix B1) was administered to learners in the control and intervention conditions before and after the VRG intervention period. The tests of decoding and single word reading included: (a) the Test of Word Reading Efficiency (TOWRE) (Wagner, Torgesen, & Rashotte, 1999): Sight word reading efficiency subtest, (b) the WIAT-II (Wechsler, 2001): Word reading subtest and (c) the WIAT-II: Pseudoword decoding subtest. The rapid naming tests included: (a) the Rapid Automatized Naming and Rapid Alternating Stimulus Test (RAN/ RAS) (Wolf & Denckla, 2005): Objects subtest and (b) the RAN/ RAS: Letters subtest. The tests of contextual reading for rate, accuracy and comprehension included: (a) the WIAT-II: Reading comprehension subtest and (b) the Burns and Roe Informal Reading Inventory – 8th edition (Burns & Roe, 2010) (which includes measures of reading comprehension, reading rate, reading errors and reading self-corrections). The test for receptive vocabulary was: (a) the BPVS (Dunn, Whetton, & Burley, 1997).

The TOWRE, WIAT-II, RAN/ RAS and BPVS are considered reliable and valid standardised measures for predicting, assessing, and measuring changes in children's reading and reading-related skills (Dunn et al., 1997; Hagan-Burke, Burke, & Crowder, 2006; Knight & Galletly, 2006; Norton & Wolf, 2012; Sloat, Beswick, & Willms, 2007; Wagner et al., 1999; Wechsler, 2001; Wolf & Denckla, 2005). The Burns and Roe Informal Reading Inventory (henceforth referred to as the Burns and Roe) has been shown to offer valuable descriptive information related to learners' grade equivalent reading skills, independent reading level, instructional level, frustration level and listening comprehension level (Burns & Roe, 2010). It should be noted that the assessments in the battery were not developed for or normed on the population of South African children. However, to the researcher's knowledge, no reliable and valid South African assessment measures of reading and receptive vocabulary currently exist. To account for this limitation, raw scores rather than standard scores were used for statistical analysis of results.

An audio recording device was used to record the assessments. Desktop computers, laptop computers and iPads with internet access were used at the schools to deliver the VRG programme.

3.2.8. Procedure

3.2.8.1. The VRG intervention.

Learners in the intervention group attended three 20- to 30-minute sessions of the VRG programme a week for ten weeks while learners in the control group continued with regular school activities. Peer mentors were trained how to navigate the VRG and provide support and feedback to the struggling reader. Peer mentors were randomly assigned to children in the intervention group (1:1). The VRG

programme consisted of reward-based passage and word-level reading activities aimed to improve learners' reading accuracy, rate, vocabulary and comprehension. Detailed information related to the VRG programme is presented in chapter two.

3.2.8.2. Data collection.

The researcher was granted permission to access the raw data from the 2017 VRG study. The data was used to create a sample by forming participant pairs according to specific matching criteria. The criteria enabled a sample of 20 participants (10 pairs) to be selected from the pool of 93 learners' data. Only the data from the generated pairs was examined for the retrospective analysis of the current study.

2.2.8.3. Data management.

To protect participants' privacy, the data was stored on password protected computers and only accessible to the researcher and the research supervisors who did not disclose identifiable information to others or include it in this report (World Medical Association, 2013). The data was not used for any purpose save the analysis described in this chapter.

3.2.9. Data Analysis

The results of the standardised and informal assessment measures were analysed to determine the effectiveness of the VRG intervention. The statistical methods were chosen according to the research questions that were posed. Firstly, paired samples t-tests were used to determine whether there was a statistically significant difference between the control and intervention groups at pre-test to evaluate whether the groups were well-matched and could be considered equivalent before intervention began. Secondly, independent samples t-tests for gain scores were conducted to determine whether there was a statistically significant difference between the groups' improvements from pre- to post-test. The paired samples t-tests and independent samples t-tests were undertaken in Statistical Package for Social Sciences (SPSS version 25). Lastly, qualitative descriptions of the matched pairs' improvements were made.

The researcher consulted and received support from the primary supervisor when performing each step of the statistical operations. The supervisor verified that correct procedures were followed when capturing and analysing the data on SPSS and that the results were accurate and free from errors. Raw scores were used for analysis because the assessments were not normed on South African children and standard scores could not be assumed to be appropriate measures of learners' skills.

3.2.10. Ethical Considerations

The analysis conducted in the current study did not require further data collection. The 2017 VRG study was granted ethical approval by the University of Cape Town (UCT) Faculty of Health Sciences Human Research Ethics Committee (HREC) (reference number 154/2016). Parental consent and learner assent were provided for the data collected to be analysed. The current study forms part of the analysis. Ethical principles were maintained so that the researcher was not able to access personal information about the participants (only anonymised data regarding the participants was obtained).

3.2.11. Summary of Retrospective Analysis

The methodology for the retrospective analysis has been described. A sample was created from a pool of data from a previous VRG study to investigate whether, with a matched participant design, VRG intervention provided by peer reading partners was effective in improving mainstream learners' reading skills. The findings of the retrospective analysis led the researcher to question whether the characteristics of the struggling readers and the identity of the reading partners acted as important variables in determining the effectiveness of the programme. These hypotheses resulted in the development of a study which used struggling readers with special educational needs and adult SLT reading partners to investigate the effectiveness of the VRG programme. The methodology for this study will be described in the next section of the chapter.

3.3. Prospective Study

3.3.1. Introduction to Prospective Study

The results of the retrospective analysis led the researcher to pose the question, was the effectiveness of the VRG programme influenced by the characteristics of the learners with reading difficulties and the identity of the partners providing support to the struggling readers? The prospective study therefore differed from the retrospective analysis in these two key areas.

3.3.2. Research Question

The research question was: Does the VRG intervention improve the reading skills of grade three to six learners with reading difficulties from a school for learners with special educational needs (LSEN) when the programme is delivered by SLTs?

3.3.3. Aim

The aim of the study was to determine the effectiveness of SLT-delivered VRG intervention for grade three to six learners with reading difficulties from an LSEN school.

3.3.4. Objectives

The objectives of the study were:

- (1) To describe changes in learners' reading (accuracy, rate, vocabulary and comprehension) after VRG intervention.
- (2) To describe learners' attitudes (thoughts and feelings) towards the VRG and their intervention experiences.

3.3.5. Research Design

The study used a mixed methods design. Specifically, a convergent mixed methods design was used where both quantitative and qualitative data was collected and analysed separately (Creswell, 2014; Venkatesh, Brown, & Bala, 2013). This design was chosen because it allowed more comprehensive data to be collected than if either a quantitative or qualitative approach had been used in isolation and it allowed the VRG intervention to be explored from two different perspectives; first, whether it improved learners' reading skills and second, participants' attitudes towards the programme (Creswell, 2014; Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2010; Venkatesh et al., 2013).

A quantitative, matched subject design was used for the first objective of the study. This design was selected for the same reasons as mentioned in the retrospective analysis methodology as well as to allow ease of comparison between the retrospective analysis and prospective study results.

A qualitative, descriptive design with an interpretive framework was used for the second objective of the study. This selection was used to explore phenomena which had not been previously investigated; to allow in-depth and rich information related to participants' thoughts and feelings, subjective realities and experiences to emerge; and to promote the development of naturalistic results (Anderson, 2010; Durrheim, 2006; Terre Blanche & Durrheim, 2006; Terre Blanche, Kelly & Durrheim, 2006; Willig, 2008).

3.3.6. Participants

3.3.6.1. Participant description.

The participants were 20 learners from a public school for LSEN in Cape Town. There were ten participants in the intervention group and ten in the control group. The learners were in grades three to six and had teacher-identified reading difficulties. The sample consisted of 14 males and six females. There were five learners from each of the grades three, four, five and six. The average age of the learners at pre-test was 11 years 3 months. The primary diagnoses of the learners were as follows: one with physical disability (PD), one with attention deficit and hyperactivity disorder (ADHD), one with

autism spectrum disorder (ASD), one with hearing loss (who had hearing aids bilaterally) (HL) and 16 learners with specific learning disability (SLD). The additional intervention status of the learners during the study period was as follows: six learners who had previously been discharged from school speech therapy services (DST), three learners who were on the school speech therapy waiting list (STWL), two learners were receiving language therapy (LT), one learner was on the school remedial waiting list (RWL), and five learners were receiving remedial (R), and these categories were not applicable (NA) for three learners. Information related to participant characteristics is displayed in Table 8.

Table 8: Prospective study participant characteristics

Group n=20	Primary diagnosis					Grade				Additional intervention						Pre-test age (M)	Sex	
	PD	ADHD	ASD	HL	SLD	3	4	5	6	DST	STWL	LT	RWL	R	NA		M	F
Intervention	0	1	1	1	7	1	3	3	3	3	1	2	0	2	2	11; 6	7	3
Control	1	0	0	0	9	4	2	2	2	3	2	0	1	3	1	11; 0	7	3

Note. PD refers to physical disability. ADHD refers to attention deficit and hyperactivity disorder. ASD refers to autism spectrum disorder. HL refers to hearing loss. SLD refers to specific learning disability. DST means discharged from school speech therapy services. STW means on school speech therapy waiting list. LT means language therapy. R means remedial. NA refers to children who did not fall into other therapy service categories. (M) refers to mean. M refers to male. F refers to female.

3.3.6.2. Inclusion criteria.

When invited to participate in the study, the school was informed that the following criteria needed to be met:

- (a) Recognised as a school for LSEN or have an LSEN division or class.
- (b) English as the language of learning and teaching or English as one of the languages of instruction in a dual medium school.
- (c) Access to computers with internet and sound output.
- (d) School, parental and learner willingness for participants to be excused from non-core academic activities or to attend intervention half an hour before or after the school day.

The first school which was contacted fulfilled the requirements and accepted the invitation to participate in the study. The school had a computer lab with internet access, but it was used as a teaching venue for classes. Therefore, intervention took place in a therapy room which had internet access and the research assistants brought devices (laptop computer and iPad) to use for VRG intervention. The principal and school teaching staff were flexible with regards to criterion (d). Thus,

the researcher negotiated assessment and therapy session times with the head of the foundation and intermediate phase as well and the class teachers.

The learners with reading difficulties had:

- (g) A teacher-identified grade two or higher reading level.
- (h) Difficulties with reading (related to one or more of the components of rate, accuracy, vocabulary and comprehension) compared to grade level.
- (i) Functional English skills (defined as the ability to understand, speak, learn and read in English even if English was not a home language).
- (j) Typical vision.
- (k) Hearing within normal limits.
- (l) Adequate attention, behaviour and cooperation for working at a computer screen with a reading partner for intervals of approximately twenty minutes.

Learners with devices or aids such as glasses, contact lenses or hearing aids were not excluded from participation.

The adult reading partners were required to have/be:

- (a) An SLT at the LSEN school with a degree in speech-language therapy from a university or an external experienced SLT for school-aged children with a degree in speech-language therapy from a university.
- (b) Oral English proficiency.
- (c) English reading proficiency.
- (d) Typical vision.
- (e) Hearing within normal limits.
- (f) Motivation and commitment to working with a child with reading difficulties for a school term – as indicated by the adult him/herself as well as the principal of the school (in the case of the SLT working at the LSEN school).

The criteria were necessary so that reading partners could provide adequate reading support and feedback to learners, could view VRG text on a digital screen, and could listen to the child with reading difficulties and the VRG sound output. Criteria (a) to (c) were ensured by the researcher accessing and reviewing reading partners' curriculum vitae (CVs) with their consent. Reading partners self-reported fulfilment of criteria (a) to (f) was used.

3.3.6.3. Exclusion criteria.

There were no exclusion criteria for the school. Initially, the researcher aimed to exclude learners with reading difficulties who were receiving one-on-one or small group reading intervention at school or outside of school. However, this criterion could not be fulfilled, and all learners continued as usual with their intervention schedules during the study period. The researcher was informed of each participant's status with regard to regular interventions, (e.g., discharged from speech therapy, on speech therapy waiting list, receiving group language therapy, discharged from remedial therapy etc.).

The reading partners did not provide learners in the intervention or control conditions with any form of individual or small group reading support at school or outside of school (except to learners in the intervention condition during the VRG sessions). This criterion was upheld for the duration of the VRG programme.

3.3.6.4. Recruitment.

After ethical approval (HREC reference number 363/2018) (Appendix B2) and permission from the Western Cape Department of Basic Education had been granted (Appendix B3), the researcher invited an LSEN school to participate in the study. The school principal was contacted by email and her permission to conduct the study at the school was requested (Appendix B4). The principal provided her consent and thus, no other schools were invited to participate. Once permission was obtained, an information session (a presentation about the study) was provided at the school by the researcher. The principal, deputy principal, head of foundation phase, head of intermediate phase and the school SLTs attended. The staff members were given a chance to ask questions and decisions related to how the study would be carried out at the school were made. The school SLTs were invited to participate as reading partners for learners in the study (Appendix B5). However, due to caseload and time schedule constraints, none of the school SLTs volunteered to participate. After the information session, the head of the foundation and intermediate phase met with the grade three to six class teachers and provided them with information about the study. Teachers were asked to decide which learners in their classes met the participation criteria. The teachers made their decisions by reviewing each learner's school folder and performance in reading tests which had been conducted in the first and second school terms. Then, they sent letters containing information about the study which had consent forms attached (Appendix B6) home to the parents of those identified as potential candidates.

Class teachers collected the parental consent forms and recorded the date on which each learner's form was returned. Subsequently, the researcher went to the school to collect the forms and dates. The researcher selected the first five forms to be returned from each grade which indicated parental consent and the 20 learners represented who provided verbal assent (Appendix B7) became study participants.

Two research assistants were recruited via email and personal contacts. Both indicated interest and provided their CVs. The researcher reviewed the CVs and found that both individuals met the criteria for participation. The research assistants thus became the two SLT reading partners for the study and were paid for their time.

3.3.6.5. Sampling methods.

Convenience, non-probability sampling was used for practical and financial reasons (Durrheim & Painter, 2006; Pring, 2005). A random sample was not considered necessary because the effectiveness of the VRG intervention was in its early stages of being explored (Durrheim & Painter, 2006).

3.3.6.6. Sample size.

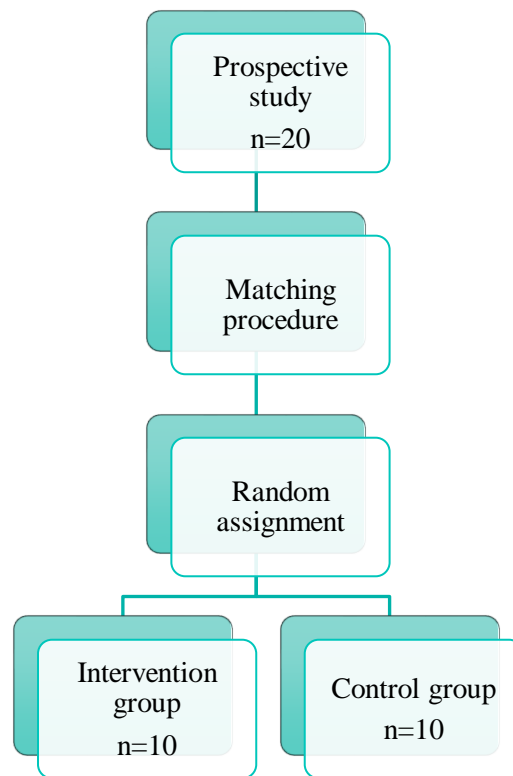


Figure 2: Prospective study sample characteristics

The sample consisted of 20 learners (ten in the intervention condition and ten in the control condition). Figure 2 shows information related to the prospective study sample size, matching procedure and random assignment of participants into the intervention and control group. None of the participants dropped out of the study. The small sample size was selected for the following reasons: (1) to ensure feasibility of the study; (2) to decrease the financial cost of the study (associated with paying research assistants to conduct assessments and deliver the intervention); (3) to enable in-depth analysis of the qualitative data (Durrheim, 2006; Durrheim & Painter, 2006); (4) to follow the recommendation of Pascoe et al. (in preparation) who suggested that in-depth analysis of individual

participants' quantitative data would promote better understanding of factors related to the effectiveness of the VRG; and (5) because studies comparable in topic and design have used similar sample sizes successfully (Seiler, 2015; Treat, 2013; Wren & Roulstone, 2008).

To reduce limitations associated with having a small sample size, the following measures were implemented: (1) participants were matched on specific criteria before being randomly assigned so that there was a comparable control participant for each intervention participant; (2) attempts to ensure study reliability and rigour were made (e.g., training of the reading partners, rescoring a sample of assessments, piloting of the interview questions, interview skill training, checking the accuracy of a sample of the interview transcriptions, checking the generated themes); and (3) the methodology of the prospective study has been described in detail so that the study could be replicated across different contexts and participants – thereby increasing its external validity (Durrheim & Painter 2006; Pascoe et al., 2013; Pring, 2005; Shadish et al., 2002; Vance & Clegg, 2012).

3.3.6.7. Matching.

Caliper matching was used for the retrospective analysis because there was a large pool of data from which to form participant pairs. In comparison, nearest-neighbour matching was used for the prospective study so that each participant could be matched to another (i.e., so that none of the participants from the small 20-participant data set were excluded) (Lunt, 2014). Thus, participants with the closest standard scores (the lowest differences in scores) on pre-intervention measures of reading ability for the WIAT-II subtests of (1) word reading, (2) pseudoword decoding, (3) reading comprehension and (4) the BPVS receptive vocabulary were matched. Ten matched pairs were formed in this way.

The researcher performed the nearest-neighbour matching. The primary supervisor checked the matches to ensure that the best possible pairs (learners with the closest scores) had been formed. No changes were deemed necessary. The mean (*M*) differences in scores between the formed pairs were as follows: WIAT-II word reading subtest (*M*=6.1), WIAT-II pseudoword decoding subtest (*M*=6.3), WIAT-II reading comprehension subtest (*M*=8.3), BPVS (*M*=9) and sum difference of the four measures (*M*=29.7). Table 9 shows the participant characteristics and pre-test scores for each matched participant pair.

3.3.6.8. Randomisation.

An online random number generator (www.random.org) was used to randomly assign learners to the intervention and control groups. Each learner in each pair was given a number using the generator that was either one or two. Each participant numbered one was assigned to the intervention group; each

participant numbered two was assigned to the control group. Thus, each match had one participant randomly assigned to the intervention group and one participant randomly assigned to the control group.

The ten learners assigned to the intervention group were randomly allocated an SLT reading partner (research assistant) using the online random number generator. Using the generator, one research assistant was numbered one and the other numbered two. The generator was then used to give the intervention participants numbers (either one or two). All participants with the number one were assigned to the researcher numbered one; likewise, all participants with the number two were assigned to the researcher numbered two. This process resulted in each SLT being randomly allocated five learners who they were responsible for providing the VRG intervention to at the school.

Table 9: Prospective study participant characteristics and pre-test standard scores on matching outcome measures

Matched pair	Randomisation	Grade	Sex	WIAT-II word reading	WIAT-II pseudoword decoding	WIAT-II reading comprehension	BPVS	Total score difference
Participant A Participant B <i>Score difference</i>	Intervention Control	6 3	F M	76 74 2	76 85 9	98 89 9	72 60 12	32
Participant C Participant D <i>Score difference</i>	Intervention Control	5 3	M F	76 74 2	68 79 11	88 92 4	90 111 21	38
Participant E Participant F <i>Score difference</i>	Intervention Control	5 3	F M	76 91 15	102 100 2	90 88 2	80 87 7	26
Participant G Participant H <i>Score difference</i>	Intervention Control	3 4	M F	69 74 5	83 70 13	81 80 1	89 80 9	28
Participant I Participant J <i>Score difference</i>	Intervention Control	4 3	M M	74 73 1	74 77 3	71 73 2	72 57 15	21
Participant K Participant L <i>Score difference</i>	Intervention Control	4 6	F M	93 101 8	99 87 12	105 103 2	70 63 7	29
Participant M Participant N <i>Score difference</i>	Intervention Control	4 5	M F	69 69 0	63 67 4	74 67 7	89 82 7	18
Participant O Participant P <i>Score difference</i>	Intervention Control	5 6	M M	78 81 3	74 75 1	80 107 27	88 88 0	31
Participant Q Participant R <i>Score difference</i>	Intervention Control	6 5	M M	84 74 10	63 69 6	82 67 15	85 89 4	35
Participant S Participant T <i>Score difference</i>	Intervention Control	6 4	M M	77 62 15	62 64 2	81 67 14	55 47 8	39
Mean score difference				6.1	6.3	8.3	9	29.7

Note. M refers to male. F refers to female.

3.3.7. Materials and Measures

The same materials used in the retrospective analysis were used for the prospective study. The measures were the same as those used in the retrospective analysis except that the additional measures of the reading speed measure of the WIAT-II, the reading target words measure of the WIAT-II and the internal VRG assessment measures of rate, accuracy and comprehension were conducted as well. Appendix B8 shows the assessment battery for the prospective study.

3.3.8. Research Tools

An interview schedule (Appendix B9) was used to conduct the semi-structured interviews for the qualitative component of the study. The questions in the schedule were reviewed and refined by a panel of SLTs (researchers and clinicians) to ensure the questions were suitable for obtaining information related to the study objectives and that questions were easy to understand (Kallio, Pietilä, Johnson, & Kangasniemi, 2016; Pring, 2005).

3.3.9. Pilot Interviews

The interview schedule was piloted with a child whose parent gave informed consent (Appendix B10) and who herself gave verbal assent (Appendix B11). The child was a grade three female from a mainstream school in Cape Town who was familiar with using the VRG at home with her mother as the reading partner. The researcher interviewed the child. The child showed understanding of the questions and provided comprehensive responses without difficulty. This suggested that the interview schedule was suitable and would allow the qualitative objective of the study to be achieved (Kallio et al., 2016; Pring, 2005).

3.3.10. Study Personnel

An experienced qualitative post-graduate researcher from UCT provided semi-structured interview training to the researcher. The expert panel who reviewed the interview questions included SLTs familiar with the VRG (the supervisor, the co-supervisor, one of the research assistants, and Elizabeth Nadler-Nir who designed the VRG programme). Nadler-Nir has a master's degree in speech-language pathology from UCT and more than 15 years of experience working with learners with literacy difficulties. Nadler-Nir provided the training session to the research assistants. One research assistant had a master's degree in speech-language pathology and was in her sixth year of working as an SLT with children. At the start of the data collection period, she had been working for three and a half years as an SLT at a practice for learners with language and literacy difficulties. The other research assistant had a bachelor's degree in speech-language pathology and, at the start of the data collection period, had two and a half years of experience working as an SLT with children.

The researcher had a bachelor of science in speech-language pathology and was working as an SLT at a paediatric hospital in Cape Town at the time of the study.

3.3.11. Procedure

3.3.11.1. Data collection.

The data collection for the study took place over a thirteen-week period. There were twelve weeks of active data collection and one week where no data collection was possible because of school holidays. Of the twelve weeks of active data collection, the first and last week were spent on participant assessments and the middle ten weeks were spent on VRG intervention. Table 10 displays information related to the timeline for data collection.

Table 10: Prospective study data collection timeline

Week	Learner participants		Reading partners
1	Assessment: Standardised language and literacy battery and in-built VRG measures		Assessment of participants Attend training about VRG and how to facilitate struggling readers with the programme Allocated to children in the intervention group
	Randomisation		
	Intervention group	Control group	
2–10	Intervention 3 x 30 minute sessions each week	Regular activities	Support intervention learners
11	School holiday		
12	Intervention 3 x 30 minute sessions	Regular activities	Support intervention learners
13	Re-assessment with standardised language and literacy battery and in-built VRG measures	Re-assessment with standardised language and literacy battery and in-built VRG measures	Assessment of participants
	Semi-structured interviews	Regular activities	

3.3.11.2. Permission.

The prospective study began following the UCT Faculty of Health Sciences HREC approval, the Western Cape Department of Basic Education authorisation, school acceptance, parental consent and child assent.

3.3.11.3. Pre-intervention assessment.

In the first week the participants were assessed with the assessment battery and the inbuilt VRG measures. The purpose of the assessments was to match participants, provide intervention at the

appropriate level for each participant and to enable pre- and post-intervention results to be compared to determine whether VRG intervention resulted in changes in reading skills.

Before data collection commenced, the researcher provided a one-hour training session to the research assistants which focused on the protocol for administering and scoring each assessment in the battery. The training aimed to ensure uniformity and consistency in the way each learner was assessed and scored (inter-rater reliability). The researcher and the research assistants were each given a set of the assessment manuals, score sheets and assessment stimuli books to further familiarise themselves with before the assessment time.

The researcher and the research assistants administered the assessments in the first week of the study. They were randomly assigned participants to assess. Each learner was assessed in one session (which was approximately one hour in duration) by one of the SLTs. The assessments were audio recorded with a device (Samsung SM-G532F) and subtests which required rate measurements were timed.

Intra-rater reliability was upheld by the researcher rechecking the scoring of a random sample of 20 percent of the assessments she had administered by reviewing audio recordings and checking the accuracy of the scoring (e.g., that points were awarded when the response was correct and not awarded when incorrect), totalling the raw scores of each subtest, and finding the associated percentile rank and standard scores associated with each raw score) (Dobinson & Wren, 2013). Inter-rater reliability was upheld by the researcher rescoring a random sample of 20 percent of the assessments conducted by each of the research assistants by reviewing audio recordings and checking the accuracy of the scoring (Dobinson & Wren, 2013). The inter-rater reliability was 98.97 percent. Once all participants' assessment scores had been finalised, the data were used to match participants and then randomly assign learners to the intervention and control conditions. Lastly, the researcher wrote a short assessment report for each learner which detailed his or her strengths and weaknesses related to the tests conducted. These reports were sent to the parents of each participant.

3.3.11.4. Training workshop.

Elizabeth Nadler-Nir provided a free training workshop at the school on how to access, navigate and use the VRG programme as well as how to be an effective reading partner to learners using the programme. The school teaching and therapy staff were invited to attend. The workshop was attended by the researcher, the research assistants, the school SLTs and one of the school occupational therapists. The workshop was one and a half hours long and took place during non-work hours (in the afternoon after the school academic day had ended). The workshop took place in the school computer lab. Nadler-Nir taught skills related to offering support and encouragement to the struggling reader, responding appropriately to reading errors, and promoting the reading skill development of the reader (rate, accuracy, vocabulary and comprehension). Video recordings of an adult acting as the VRG

reading partner of a child with reading difficulties were shared and discussed. Everyone was given a chance to explore the VRG programme on a computer. Role plays were also conducted (each individual had a turn to act as the struggling reader and as the reading partner). Throughout the session individuals' questions were answered as they arose.

Both SLT research assistants were given their own personal VRG accounts before the intervention period began and for the duration of the study period. The accounts enabled them to become familiar with all the VRG activities and to access training videos designed to teach individuals how to deliver the VRG intervention. The research assistants were given the opportunity to ask the researcher questions related to the VRG before intervention started at the school and during the intervention period.

3.3.11.5. The VRG intervention.

Learners in the intervention condition received the VRG intervention for ten weeks for three thirty-minute sessions per week. The research assistants completed a session tracking form each day for each of their participants to monitor and enforce the study protocol (Appendix B12). The sessions occurred during both academic and non-academic school activities according to timetables which were individually negotiated with class teachers for each intervention learner. Intervention participants received the VRG intervention in a quiet room which had internet access at the school. One research assistant delivered intervention on a laptop while the other used an iPad. Research assistants accessed learners' personal online accounts by entering the username and password details via the online website. Each learner had his/ her own online account which was used for individualised VRG therapy. Only the research assistants had access to the learners' passwords.

With the exception of one week where one of the SLT research assistants delivered the VRG intervention to all ten children; in all other weeks the same research assistant provided therapy to the same five children each week. Intervention sessions were individual - each learner received one-on-one therapy from his/ her allocated reading partner. At all sessions, both the learner and his/her research assistant reading partner were present (learners did not use the VRG programme on their own). Reading partners were present to guide the intervention and to provide learner feedback and support.

Information related to VRG intervention intensity for each intervention participant is displayed in Table 11. Intervention participants had an average (mode) of three VRG sessions per week, an average (mean) of 28.84 minutes per session, an average (mean) of 21 VRG sessions and each participant received an average (mean) of 610.6 minutes of total intervention (which is equivalent to 10 hours 10 minutes of intervention).

Table 11: Prospective study VRG intervention intensity data for intervention participants

Intervention participant	Mode number of therapy sessions per week	Mean number of minutes per session	Total number of intervention sessions	Total minutes of intervention time
A	2	28.69	19	545
C	3	27.08	23	623
E	3	29	20	580
G	3	27.82	23	640
I	3	28.09	22	618
K	3	29.95	24	719
M	3	28.47	23	655
O	3	28.85	20	577
Q	2	30	19	570
S	2	30.47	19	579
Averages	3	28.84	21	610.6

3.3.11.6. Control condition.

Learners in the control condition continued with regular school activities during the ten weeks of intervention.

3.3.11.7. Post-intervention assessment.

In the thirteenth week, learners in the intervention and control conditions were re-assessed with the standardised assessments and VRG measures. Before post-intervention assessments began, the researcher provided a half an hour assessment revision training session to the research assistants which emphasised the protocol for administering and scoring each assessment in the battery. The researcher and research assistants conducted the assessments. To decrease potential bias, research assistants did not assess the children they had been responsible for providing therapy to. Moreover, they were randomly allocated participants that had not been on their caseload to assess. The same procedures used to increase the inter-rater and intra-rater reliability of the pre-intervention assessment results were used for the post-intervention assessments (e.g., checking the scoring of 20 percent of the assessments conducted by the researcher and 20 percent of the assessments conducted by each of the research assistants). The inter-rater reliability was 98.68 percent. The researcher wrote brief assessment reports for all participants, detailing their strengths and weaknesses related to the areas assessed as well as the improvements which had been made over the course of the study period. These reports were sent to learners' parents.

3.3.11.8. Interviews.

Semi-structured interviews were used because they give participants the freedom to respond in as much detail as they desire, predetermined questions and relevant spontaneous follow-up questions can be asked, verbal and non-verbal probing techniques can be used to gather relevant information and interviewers may ask for clarification to ensure responses are being appropriately understood and interpreted (Adams & Cox, 2008; Bernard & Ryan, 2009; Kallio et al., 2016; Miller & Brewer, 2003; Payne, 2007; Willig, 2008). These factors were used and resulted in credible information being obtained about interviewees' attitudes and how they explained and contextualised their experiences (Kallio et al., 2016; Newton, 2010; Willig, 2008).

Before the interviews took place, the researcher was trained by an experienced qualitative researcher to increase her skills and promote a consistent interview approach (Pring, 2005). The training consisted of theory (provision of information related to interviewing skills) and practice, where the researcher interviewed a child and was provided with feedback and advice related to how to improve (Pring, 2005).

The semi-structured interviews for the qualitative component of the study were conducted in the final (thirteenth) week of the study. Learners in the intervention condition were individually interviewed by the researcher in a quiet venue at the school. The interviews were audio recorded on a password protected device (Samsung SM-G532F) and transferred onto a password protected computer on the same day. The recordings were then transcribed verbatim. All of the transcribed interviews were checked twice by the researcher (to ensure the audio recordings and written transcriptions were identical). Additionally, twenty percent of the transcribed interviews were randomly selected and checked by the supervisor to ensure the transcriptions accurately reflected the audio recordings (Dobinson & Wren, 2013). Once the interviews had been transcribed and checked, the audio recordings were deleted.

3.3.12. Data Analysis

Firstly, paired samples t-tests were conducted to determine whether the groups were well matched at pre-test. Next, independent samples t-tests for gains scores were conducted to determine whether there was a difference between the intervention and control groups' improvements from pre- to post-test. The t-tests were carried out on SPSS version 25. Finally, qualitative descriptions of the matched pairs' gains were made.

Thematic analysis was used to analyse the qualitative data (the transcribed semi-structured interviews) to evaluate learners' attitudes towards the VRG and their intervention experiences (Braun & Clarke, 2006, 2014). Thematic analysis was used because it enabled meaningful, rich and context-specific

explanations of participants' attitudes to emerge (Alhojailan, 2012; Braun & Clarke, 2006, 2014; Smith, 2007; Terre Blanche, Durrheim, & Kelly, 2006). Descriptive statistics were used when reporting on how many individuals expressed a certain theme by using terms such as "the majority of participants" and "half of the participants" (Tredoux & Smith, 2006).

Braun and Clarke's (2006, 2014) steps of thematic analysis were followed:

1. Familiarisation with the transcribed data through reading it numerous times and recording of preliminary ideas and themes.
2. Generation of initial codes that reflect the patterns of the whole data set and collation of pertinent data for each code.
3. Sorting codes into possible themes and collation of appropriate data for each theme.
4. Reviewing and reworking themes by checking their relevance to the coded data and the whole data set.
5. Naming and description of themes.
6. Reporting on each theme and selecting relevant supporting extracts.

To promote credibility of the qualitative results, the researcher used reflexivity to reflect on her role in interpreting the data so that impositions of meaning did not occur and she checked and revised the themes so that they captured trends which individual participants expressed as well as trends in the whole data set (Durrheim & Painter, 2006; Terre Blanche et al., 2006; Trochim, 2002; Willig, 2008). The supervisor compared the transcriptions to the themes which the researcher had developed to promote the dependability of the results (Trochim, 2002; Willig, 2008). The supervisor was satisfied that the themes accurately represented the data and thus no changes were made.

3.3.13. Ethical Considerations

The research began after the UCT Faculty of Health Sciences HREC had given approval for the study. The study was guided by the World Medical Association Declaration of Helsinki (2013) ethical principles for medical research involving human participants as well as Emanuel, Wendler, and Grady's (2000) requirements for ethical clinical research and the four widely accepted ethical principles of autonomy, beneficence, non-maleficence and justice (Wassenaar, 2006).

3.3.13.1. Autonomy.

Informed consent personifies the principle of autonomy (Emanuel et al., 2000). To honour the principle, participants were made aware of pertinent information related to the study (e.g., the purpose, methods, meaning of being assigned to the control or intervention group, associated risks and benefits as well as the alternatives to participating) (Emanuel et al., 2000; World Medical Association,

2013). Moreover, they were informed that participation in the study was voluntary and that they had the right to withdraw from the study at any time without any repercussions related to their schooling, or remedial/ therapy services (Emanuel et al., 2000). Children are considered a vulnerable group. Thus, their parents or legal guardians were required to give informed consent and the children were required to give verbal assent (World Medical Association, 2013). The participants were made aware of their right to be informed of the general results of the study (World Medical Association, 2013). The school, parents and participants were provided with feedback related to the outcomes of the study.

It was essential that the participants' privacy was protected and that their personal information remained confidential (World Medical Association, 2013). This was ensured by storing electronic data on password protected devices and hard data in secure filing cabinets. Identifiable information was stored separately from the results. No identifiable information about the participants was disclosed to the staff at the school (or other individuals) and it was not used in this report. For the qualitative results section of the report, participants were given random codes (e.g. "Participant A") to avoid identification. Some teachers and learners were aware of who was participating in the intervention group, as certain children were absent from specific school activities three times per week. To reduce any discomfort associated with being known to participate, each learner was informed of the study procedure and that they could withdraw from participation if they desired.

3.3.13.2. Beneficence.

Beneficence refers to the need to optimise the benefit which participants may gain from participating in a study (Wassenaar, 2006). It was possible that the intervention learners' reading skills would improve as a result of the intervention and that reading with a supportive partner would increase their reading motivation. Reading partners may have benefitted from the experience of helping children develop their reading skills by increasing their knowledge of how to help struggling readers. The parents of learners in the intervention and control conditions received an assessment report for their initial and final assessments. Additionally, learners in the control condition were provided with a VRG online account to use the programme at home in the term following data collection for the study. After data collection was complete, the researcher provided a one-hour training workshop to the parents of the control participants to equip them to use the VRG programme at home with their children. It should be noted that the participants were not paid and did not receive any type of reward for being involved in the programme.

South Africa faces a crisis in education related to poor learner literacy levels (chapter one). The study was important because it aimed to find a local, practical and innovative solution to children's reading difficulties and it contributed to the international literature on ICT-based reading treatments.

3.3.13.3. Non-maleficence.

Nonmaleficence refers to avoiding causing any form of harm to participants (Wassenaar, 2006). The study had no known risks associated with participation and the participants came to no known harm as a result of participating. The assessment and intervention occurred at the learners' school, which was a familiar, safe environment. The researcher had no suspected cases of abuse or neglect to report.

3.3.13.4. Justice.

Justice was upheld by treating participants fairly (Wassenaar, 2006). Participants were included based on the predetermined inclusion and exclusion criteria to eliminate bias related to sampling. All learners who met the criteria had equal opportunities to participate. Learners allocated to the control group were given access to a VRG online account to use at home the school term following the one in which data was collected (World Medical Association, 2013). Learners whose assessments revealed reading or language difficulties who were not already on the school speech therapy waiting list were referred to the school SLTs and parents were informed of the reasons for referral.

3.4. Chapter Conclusion

This chapter detailed the methodology of the retrospective analysis, which investigated the effectiveness of peer-supported VRG intervention in mainstream schools, and the prospective study, that evaluated the impact of SLT-supported VRG intervention in an LSEN school. The results of the study will be provided in the next two chapters.

Chapter 4

Retrospective analysis: Results and discussion

4.1. Introduction to Chapter

This chapter presents the findings of the retrospective analysis. First, the results of the paired samples t-tests comparing the intervention and control groups at pre-test are presented. Second, the independent samples t-tests for gain scores at post-test are discussed. Third, descriptive patterns of the participant pairs' improvements are outlined. A discussion of the results follows, including their consideration in light of ICT-based reading intervention research. Factors contributing to the results are explored and recommendations for future research are made. The recommendations are used to support the rationale for the prospective study that forms the focus of chapter five.

4.2. Results

4.2.1. Pre-test: Comparison between intervention and control groups.

To compare the reading skills of the experimental and control learners at the outset of the VRG intervention, paired samples t-tests of pre-test scores for the assessment measures were completed. This was done to determine whether the groups were well-matched at pre-test and could be considered equivalent. Table 12 (Appendix C1) presents the results of the paired samples t-tests for the assessment measures at pre-test. The results did not differ significantly on any of the measures, using a significance level of $p < .05$, except for the WIAT-II word reading subtest, where learners in the control group's scores ($M=99.20$, $SD=13.19$) were significantly higher than those in the intervention group ($M=94.50$, $SD=99.2$) at pre-test ($t(9) = -2.33$, $p < .044$). The WIAT-II word reading measure was kept in the analysis. The groups were otherwise equivalent at pre-test.

4.2.2. Post-test: Comparison between gain scores of intervention and control groups.

The intervention and control groups' raw score pre- and post-test means and standard deviations for the outcome measures and each group's gain score (showing the difference between pre- and post-test raw score results) are displayed in Table 13. When interpreting the gain scores, it is important to be aware that positive gains indicate improvement (better performance) for most of the outcome measures. Negative gains indicate improvement for the Burns and Roe self-corrections and reading errors component as well as the RAN/ RAS objects and letters subtests. For these measures a lower score indicates fewer mistakes were made or items were named faster (fewer seconds taken to complete the tasks).

Table 13: Retrospective analysis participants' pre- and post-test raw score results and the gain scores for the outcome measures

Assessment	Group	Pre-test	Post-test	Gain Score	
		M (SD)	M (SD)	M (SD)	
BPVS	Intervention	82.2 (14.84)	86.8 (9.71)	4.6 (7.56)	
	Control	89.2 (20.9)	94.4 (19.54)	5.2 (12.24)	
Burns and Roe	Comprehension	Intervention	5.85 (2.34)	6.1 (1.69)	0.25 (1.82)
		Control	5.60 (1.54)	6.8 (1.75)	1.2 (1.70)
	Words per minute	Intervention	81.9 (29.68)	99.7 (27.68)	17.8 (10.92)
		Control	94.8 (34.97)	102.8 (29.27)	8.0 (20.91)
	Self-corrections	Intervention	2.1 (2.07)	1.1 (1.19)	-1.0 (2.62)
		Control	1.6 (1.17)	2.5 (1.5)	0.9 (1.79)
	Errors	Intervention	8.3 (11.67)	4.2 (3.42)	-4.1 (8.88)
		Control	4.8 (3.45)	2.3 (2.31)	-2.5 (2.50)
RAN/RAS	Objects	Intervention	44.9 (6.11)	44.7 (8.20)	-0.2 (5.67)
		Control	46.8 (8.01)	44.0 (6.87)	-2.8 (3.25)
	Letters	Intervention	29.9 (8.65)	27.3 (6.30)	-2.6 (8.88)
		Control	28.2 (8.71)	25.2 (5.59)	-3.0 (2.50)
TOWRE sight word efficiency subtest	Intervention	59.4 (16.75)	63.1 (12.22)	3.7 (6.97)	
	Control	59.3 (14.10)	65 (12.83)	5.7 (5.96)	
WIAT-II	Word reading	Intervention	94.5 (12.78)	97.5 (13.97)	3.0 (4.92)
		Control	99.2 (13.19)	100.9 (11.39)	1.7 (4.57)
	Pseudoword decoding	Intervention	31.7 (10.97)	33.5 (13.26)	1.8 (7.67)
		Control	35.1 (8.99)	39.1 (7.03)	4.0 (4.830)
	Reading comprehension	Intervention	26.7 (10.18)	30.1 (9.65)	3.4 (8.47)
		Control	25.8 (11.88)	30.3 (11.0)	4.5 (10.14)

Note. Raw scores were used. M refers to mean. SD refers to standard deviation. BPVS is the British Picture Vocabulary Scale. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. Results which are discussed further in the text are highlighted.

Independent samples t-tests were conducted to determine whether there was a significant difference between the raw score gains made by intervention and control groups on completion of the study. The results are presented in Table 14 (Appendix C2). The difference in the gain scores were not

statistically significant for any of the outcome measures. The gain score results revealed that both the intervention and control group made improvements from pre- to post-test on all the assessments (with the exception of the control group for the self-corrections measure where learners' self-correction rate increased rather than decreased from pre- to post-test). With this exception aside, all learners' reading accuracy, receptive vocabulary, reading rate and reading comprehension improved from pre- to post-test.

The gain score for the Burns and Roe self-correction measure was approximating significance ($p=0.075$) as a result of the intervention children making fewer self-corrections and the control children making more self-corrections during passage reading from pre- to post-test. It is possible that, in response to the VRG intervention, intervention learners began reading words correctly on their first trial and therefore did not have to self-correct as frequently.

The intervention group's gain scores for the Burns and Roe reading rate measure was higher ($M=17.8$) than that of the control group ($M=8.0$), showing that intervention learners' reading rate increased more than that of the controls from pre- to post-test. This did not reach statistical significance ($p=0.206$); however, the trend suggests the possibility that the VRG intervention promoted reading speed gains.

There was a statistically significant difference between the experimental and control groups' performance on the WIAT-II word reading measure at the beginning of the study with the control group outperforming the intervention children. However, there was no statistically significant difference between the groups' gain scores at post-test ($p=0.548$) indicating that both groups had improved relative to their respective baselines, and that the extent of the improvement was not significantly different.

4.2.3. Descriptive patterns of matched pairs.

The data were analysed for descriptive patterns between matched participant pairs. Raw score total point gains for each outcome measure and total average score gains (the mean of the pre- to post-test increases and decreases for each assessment) were calculated for the intervention and control participants in each pair. To make the calculations, the researcher represented all scores which showed skill improvement as positive, and all scores which showed decrease in performance from pre- to post-test as negative. Dyads were grouped into one of three categories: (1) intervention participant outperforms control participant, (2) control participant outperforms intervention participant, and (3) similar performance (difference between average gain scores of less than two raw score points). There were three dyads in category one, three dyads in category two and four dyads in category three. An example of a dyad from each category is presented below.

4.2.3.1. Category 1: Intervention outperforms control.

Participant I (intervention, 8 years 6 months old, grade three, male, school AB) and participant J (control, 12 years 6 months old, grade six, female, school AB) are an example of a dyad where the intervention learner outperformed the matched control from pre- to post-test. Child I improved more than child J on five of the outcome measures, child J improved more than child I on four of the assessment measures and they performed equivalently (both improved by the same number of points/ both decreased/ both did not make gains) on two of the outcome measures. Participant I improved by an average of 5.45 raw score points and child J improved by an average of 0.72 raw score points from pre- to post-test. Their average gain scores differed by 4.72 raw score points. The intervention learner in the pair thus showed slightly greater improvement than his matched control.

4.2.3.2. Category 2: Control outperforms intervention.

Participant A (intervention, 10 years 11 months old, grade five, female, school AD) and participant B (control, 10 years 4 months, grade five, male, school AD) are an example of a pair where the control learner achieved higher gains from pre- to post-test than the intervention learner. Child A improved more than child B from pre- to post-test on four outcome measures, child B improved more than child A on four outcome measures and they had equivalent performance (same gains/ both decreased/ both did not improve) on three of the outcome measures. Child B improved by an average of 8.40 raw score points from pre- to post-test whereas child A improved by an average of 5.68 points (2.72 points less than child B). The control learner therefore showed a slightly higher improvement over the course of the study period than the child who was in VRG intervention.

4.2.3.3. Category 3: Intervention and control with similar performance.

Participant G (intervention, 8 years 5 months, grade three, female, school AA) and participant H (control, 8 years 4 months, grade three, female, school AA) performed markedly similarly from pre- to post-test. Participant G showed greater gains than her matched control on five outcome measures while participant H showed greater gains on four of the outcome measures. They had equivalent shifts on two outcome measures. Participant G improved by an average of 7.63 raw score points; participant H improved by an average of 7.22 raw score points. There was a marginal 0.4 raw score point difference between their average gains.

4.2.3.4. Dyad trends conclusion.

The distribution of improvement from pre- to post-test was spread evenly across the participants in the matched pairs, with comparable numbers of intervention children outperforming their controls, control children outperforming their matched intervention participants, and participants in the pair

performing equivalently. Analysis of the dyads is in line with the statistical test results, as the intervention participants showed no advantage over the control learners after the VRG programme.

4.3. Discussion

The aim of the retrospective analysis was to determine the effectiveness of peer-delivered VRG intervention for grade three to six learners with reading difficulties from mainstream schools. The objective was to describe changes in learners' reading (accuracy, rate, and comprehension) and vocabulary after VRG intervention. Although it could be demonstrated that all participants made progress over the course of the study, the results showed that there was no statistically significant difference between the intervention and control learners at post-test. Intervention learners did not show greater gains than control learners in reading accuracy (measured by the TOWRE sight word efficiency subtest, the WIAT-II word reading subtest, the WIAT-II pseudoword decoding subtest, the Burns and Roe reading error component and the Burns and Roe self-corrections component); reading rate (measured by the words per minute component of the Burns and Roe and the RAN/ RAS objects and letters subtests); receptive vocabulary (measured by the BPVS); and reading comprehension (measured by the WIAT-II comprehension subtest and the Burns and Roe reading comprehension component) after they had participated in the VRG intervention programme. Thus, the VRG intervention, although showing positive changes in mainstream grade three to six learners with reading difficulties, did not result in gains that were significantly different to the gains made by children who were not getting this specific intervention and continued with routine classroom teaching.

Factors such as classroom reading- and language-based instruction and natural developmental progression are likely explanations for all participants' improvements (Tredoux & Smith, 2006). Seeing as the control group did not receive any type of reading therapy outside of regular classroom instruction, it is likely that these learning opportunities and typical developmental gains caused the improvements.

Analysis of trends in participant dyads revealed that there were similar numbers of intervention children who outperformed their matched controls, control children who outperformed their matched intervention participants and participant pairs who performed equivalently. Intervention learners did not make greater gains than their matched controls after the VRG programme, indicating no intervention effect.

4.3.1. Similarities to other studies.

As shown in chapter two, not all ICT-based reading programmes result in reading skill gains. Some studies conducted with foundation phase primary school learners have not shown treatment effects related to ICT-based programme use. For example, Wilkinson (2008) did not find an effect of using

the *Academy of Reading* programme on grade two and three learners' reading skills; Beaudry (2014) did not find an effect of using the programme *The First 4000 Words* on grade two children's reading and vocabulary skills; Bush's (2014) results suggested that the computer-based reading programme *Reading Assistant* did not lead to reading fluency and comprehension skill gains of grade two and three learners; Larabee et al. (2014) showed that grade one learners' reading skill gains were not related to the use of the *Build a Word – Easy Spelling with Phonics* programme; and Flis (2018) found a significant effect of *ABRACADABRA* intervention for the second language grade one learners but not the grade one learners at risk of reading difficulty. Additionally, some studies with intermediate phase learners have failed to demonstrate positive results associated with ICT-based reading programme use. For example, Given et al. (2008) found no significant difference between grade six to eight treatment and control groups after the *Fast ForWord* intervention period; James-Burdumy et al. (2009) found no significant difference between the grade five treatment and control groups' reading comprehension after use of *Read About*; Kim et al. (2010) did not discover a meaningful intervention effect associated with the use of *Read 180* for grade four to six learners; and El Zein et al. (2016) did not find reading comprehension skill improvements associated with use of *Space Voyage* with grade four to six learners. Lastly, certain studies conducted with primary school learners in both the foundation and intermediate phases do not provide support for ICT-based reading interventions. For example, Kulik (2003) found no significant positive effect of unnamed integrated learning system computer programmes on the reading achievement of grade R to six learners (although the study did find positive effects for the programmes *Writing to Read* and *Accelerated Reader*) and Dynarski et al. (2007) found no statistically significant improvement in reading associated with ICT programme use (*Destination Reading*, *Waterford Early Reading Program*, *Headsprout*, *Plato Focus*, *Academy of Reading*, *Leapfrog*, *Read 180*, and *KnowledgeBox*) for grade one and grade four learners.

These studies may have failed to show reading skill gains associated with ICT-based reading programmes because of factors such as poor or reduced implementation fidelity, insufficiently sensitive outcome measures, programmes not being individualised according to learners' reading skill strengths and weaknesses (e.g., learners not receiving training for their specific reading skill deficits), limitations of the activities within the programmes (e.g., not based on theoretical principles, not targeting appropriate reading skills, not having suitable methods for improving skills), lack of or inadequate instruction provided by facilitators (e.g., adults present to support and provide instruction to the children), and insufficient amount of time spent using the programmes. A few possible reasons for the non-significant results found for the retrospective analysis will be discussed in section 4.3.3 of this chapter.

4.3.2. Differences to other studies.

There are studies which have not found effects of ICT interventions on primary school learners' reading. However, most literature supports the use of ICT reading programmes and has found meaningful intervention effects (Becker, 1992; Blok, Oostedam, Otter, & Overmatt, 2002; Cheung & Slavin, 2011; Cheung & Slavin, 2013; Fletcher-Flinn & Gravatt, 1995; Kulik & Kulik, 1991; Moran et al., 2008; National Reading Panel, 2000; Ouyang, 1993; Soe, Koki & Chang, 2000).

Reading-based ICT intervention studies for primary school learners that are comparable to the VRG retrospective analysis have, unlike the current analysis, found positive effects on learners' reading skills. For example, ICT-based reading intervention studies with similar designs, sample sizes, grades targeted, intervention intensity, and outcome measures have found results that reflected meaningful gains in learners' reading skills (Abrami et al., 2016; Barber et al., 2018; Bennett, Gardner, Cartledge, Ramnath, & Council, 2017; Ecalle et al., 2009; Ecalle et al., 2013; Fälth et al., 2013; Gustafson et al., 2011; Kim et al., 2011; Kyle et al., 2013; Lindeblad, Nilsson, Gustafson, & Svensson, 2016; Lysenko & Abrami, 2014; Macaruso & Rodman 2009; Madden & Slavin, 2017; Mills-Tetty et al., 2009; Mize et al., 2019; Musti-Rao, Lo, & Plati, 2015; Özbek & Girli, 2017; Potocki, Ecalle, & Magnost, 2013; Saine et al., 2011; Savage, Abrami, Hipps, & Deault, 2009; Schneider et al., 2016; Solheim et al., 2018; Torgesen, Wagner, Rashotte, Herron, & Lindamood, 2010; van de Ven et al., 2017; Walcott, Marett, & Hessel, 2014; Yaw et al., 2011).

Literature searches did not generate any ICT-based reading treatment studies which made use of peer facilitators (reading partners). Only studies which used teachers, special education teachers, researchers and trained professionals to support learners during the intervention were found. It is possible that one of the reasons the retrospective analysis did not find positive treatment effects is because peer reading partners were used. This proposition is discussed further later in the chapter (~4.3.3.2.).

4.3.3. Possible reasons for the non-significant results.

In this section variables which may have influenced the study's outcomes are discussed and attempts to provide possible explanations for the null results are made.

4.3.3.1. Learners' reading skills too high at onset.

One of the possible reasons behind the failure of the programme to show significant results is that the learners' reading skills were too high at the onset of the study. The VRG was designed for struggling readers, not readers who are reading at levels appropriate for their age and grade (Nadler-Nir & Pascoe, 2016). The 2017 VRG study recruited participants by having teachers identify learners who had difficulties with reading compared to grade level. Despite the participants being identified by their

teachers as having reading difficulties, the pre-intervention assessment results of the retrospective analysis sample revealed that the majority of participants scored within the average range for their age on the measures when their standard scores were considered (Table 14 and 15).

Table 14: Pre-test reading measures: The number and percentage of retrospective analysis participants scoring within standard score ranges

Standard score	Assessment						
	Sight word reading (TOWRE)	Word reading (WIAT-II)	Pseudoword decoding (WIAT-II)	RAN/RAS: Objects	RAN/RAS: Letters	Reading comprehension (WIAT-II)	Receptive vocabulary (BPVS)
Below average (70-84)	2 (10%)	4 (20%)	2 (10%)	6 (30%)	4 (20%)	4 (20%)	4 (20%)
Low average (85-99)	13 (65%)	14 (70%)	15 (75%)	8 (40%)	8 (40%)	9 (45%)	7 (35%)
High average (100-114)	4 (20%)	2 (10%)	3 (15%)	6 (30%)	6 (30%)	7 (35%)	7 (35%)
Above average (115-129)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	2 (10%)	0 (0%)	2 (10%)

Note. BPVS is the British Picture Vocabulary Scale. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. The sample size was n=20.

Table 15: The number and percentage of retrospective analysis participants with average and below average reading speed at pre-test

Descriptor	Burns and Roe measure of reading rate (words per minute)
Below average	7 (35%)
Average	13 (65%)

Note. The sample size was n=20. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition.

A meta-analysis of the effects of ICT on reading achievement of grade R to 12 learners found that intervention had a more positive impact on learners with low academic ability than learners with middle and high academic ability (Cheung & Slavin, 2011). Another study found that grade two to five learners who had lower pre-intervention reading levels made greater gains on measures of reading ability after computer-based reading intervention than learners who had higher reading levels pre-intervention (Wise, Ring, & Olson, 2000). Moreover, a study by Fogarty et al. (2017) showed that a comprehension training ICT-based reading programme was more effective for learners who had lower level comprehension skills at pre-test than those who had skills within the low average range. Thus, it is possible that the VRG programme may have shown a greater impact had the learners had lower reading skills at the onset of the study.

4.3.3.2. Peer reading partners.

Another possible reason why intervention resulted in no reading gains may be because the intervention was facilitated by peer reading partners. There is a body of evidence which demonstrates

that peer-facilitated reading interventions can be effective in improving learners' reading skills in the areas of word identification, sight word reading, accuracy, speed, fluency, vocabulary, comprehension as well as attitudes to reading and self-esteem (Flint, 2010; Flores & Duran, 2015; Fuchs, Fuchs, & Burish, 2000; Kourea, Cartledge, Musti-Rao, 2007; Lee, 2014; Mackiewicz, Wood, Cooke, & Mazzotti, 2011; Marr, Algozzine, Kavel, Dugan, 2010; Miller, Topping, & Thurston, 2010; Oddo, Barnett, Hawkins, & Musti-Rao, 2010; Topping, Miller, Thurston, McGavock, & Conlin, 2011; Vaughn, Klingner, & Bryant, 2001). However, intervention facilitated by adults may be more effective than intervention facilitated by learners (Galuschka et al., 2014; Mathes & Fuchs, 1994).

An early but important synthesis of evidence related to peer tutoring for learners with reading difficulties found that peer tutoring was less effective than one-on-one teacher tutoring and teacher-led small group instruction (Mathes & Fuchs, 1994). Additionally, a meta-analysis found that, for studies published between 1980 and 2004, researcher-delivered intervention had a significantly larger mean effect size than teacher-delivered intervention (Scammacca et al., 2015). Similarly, another meta-analysis found that reading interventions delivered by researchers had larger short-term effect sizes than those delivered by teachers (Suggate, 2016). Finally, a meta-analysis by Galuschka et al. (2014) which examined the effectiveness of reading interventions for children with reading difficulties found a trend where interventions conducted by study researchers had higher mean effect sizes than those conducted by teachers, special educators and learners. The authors proposed that knowledge about reading difficulties in children may improve treatment efficacy (Galuschka et al., 2014). These reviews suggest that it is possible that the results of the retrospective analysis would have been more positive had adults with knowledge related to reading and reading intervention acted as the facilitators for the intervention.

4.3.3.3. Grade and age.

The retrospective analysis may not have found significantly different gains between the intervention and control groups because of the age and grade of the participants. Randomised control trials of traditional and ICT-based reading intervention methods have shown greater reading improvements for younger learners in the early primary school grades than older learners in higher grades (Kim et al., 2010; Torgesen et al., 2007; Wise et al., 2000). Systematic reviews and meta-analyses have found equivalent results related to how learner progress is related to age and grade level. They have found more positive treatment effects related to reading intervention for learners in grades R to three than for learners in grades four and above (Cheung & Slavin, 2013; Flynn et al., 2012; National Reading Panel, 2000; Wanzek et al., 2013). Therefore, reading intervention appears to be more effective for children when it takes place in the early years of primary school compared to the later years. This is likely related to younger children having greater brain plasticity and older learners' reading challenges and reading behaviours being more established (Banich & Compton, 2011). These findings suggest

that one of the possible reasons behind the null results of the retrospective analysis was that the learners in the sample reflected an age group that was difficult to impact and less likely to change in response to reading intervention than a younger sample would have been.

4.3.3.4. Intervention intensity.

The intensity of the VRG intervention may have impacted the research results. Factors which are important to consider when determining the intensity of an intervention include dose (the number of teaching episodes in a single session), dose form (the task or activity in which there is a teaching episode), dose frequency (the number of sessions per day or per week), duration (the length of each session), dosage (the cumulative intensity or total amount of intervention), the number of opportunities the learner has to make a response, the amount of corrective feedback given, and the timing of the corrective feedback (Baker, 2012; McGinty, Breit-Smith, Fan, Justice, & Kaderavek, 2011; Ross & Bengeny, 2015; Yoder, Fey, & Warren, 2012). Manipulating one or more of these intervention intensity variables could have resulted in the VRG intervention being effective. For example, it is possible that the results may have been more positive if the dose frequency and dosage of the intervention had been higher because this would have given the learners' more opportunities to practice their reading skills. Nevertheless, it is not straightforward whether the results would have improved if such factors had been increased (Baker, 2012).

Intervention intensity is a complex issue in reading research. Some research has found that increased intensity results in increased gains. For example, a study which investigated the impact of intensity on reading fluency showed that the intervention which had longer session duration (14 minutes per session) was more effective than the intervention of shorter duration (seven minutes per session) (Ross & Bengeny, 2015). It is therefore possible that longer VRG intervention sessions may have produced more meaningful results. A study which aimed to identify the best intensity of interactive book reading for learning new words discovered that response to treatment improved as intensity increased from 12 to 24 to 36 exposures but no further improvements were observed as intensity increased to 48 exposures (Storkel et al., 2017). This suggests that the number of exposures which VRG intervention participants had to learn phonics patterns, read target words and demonstrate understanding and use of vocabulary was perhaps insufficient to promote skill gains. A meta-analysis by Galuschka et al. (2014) discovered that interventions which lasted more than 12 weeks had higher effect sizes than those which lasted less than 12 weeks but this finding did not reach statistical significance. It is thus possible that more meaningful results would have been found if the VRG intervention had continued for more than ten weeks. However, this would not necessarily have been possible due to the challenges of conducting studies at schools (e.g., schools may not have given permission for intervention to be conducted for a longer period because of disruptions to school activities associated with data collection).

Other research which has investigated reading intervention intensity factors shows mixed results. For example, a study which investigated how grade two learners' reading was affected by intervention intensity (daily sessions versus twice weekly sessions) found that the daily intervention resulted in greater reading gains for reading accuracy but there were equivalent gains for comprehension and rate for both intensities (Dunn, 2015). Additionally, a study which investigated the extent to which dose frequency and dose influenced preschool children's print knowledge showed that there was a benefit to increasing the dose or the dose frequency of the intervention but increasing both had a diminishing benefit to the children's learning (McGinty et al., 2011). These studies suggest that having a greater number of VRG sessions per week or a greater amount of total VRG intervention may have led to more positive results for some but not all reading skills and that increasing one of the intensity factors may have been associated with better outcomes.

Some studies which modified intensity variables did not find changed reading outcomes. For example, in a study which evaluated different treatment schedules for grade one children, there was no significant difference in reading achievement between groups assigned to four sessions per week for 16 weeks, four sessions per week for eight weeks and two sessions per week for 16 weeks (Denton et al., 2011). Another study which examined two schedules of treatment for phonemic awareness found that the gains made from short, intense treatment (total of four hours) were as great as those made from continuous weekly treatment (total of 11 hours) (Ukrainetz, Ross, & Harm, 2009). Likewise, a study which examined response to different amounts of time in reading intervention for grade one learners found that learners' responses to the single-dose and double-dose interventions were similar (Wanzek & Vaughn, 2008). These studies suggest that the factors of dose frequency and total dosage may not necessarily have been responsible for the lack of significant outcomes found for the retrospective analysis.

Finally, meta-analyses have found similar results to the studies already discussed. A meta-analysis on the effects of ICT on reading achievement in grade R to 12 classrooms found that there was no significant difference in outcome of low versus high intensity technology interventions (Cheung & Slavin, 2011). Additionally, a meta-analysis on the effectiveness of reading interventions for grade four to 12 learners found no significant differences in learners' reading outcomes when the number of hours of intervention was considered (Wanzek et al., 2013). In conclusion, it is possible that the intervention intensity variables of the 2017 VRG study contributed to the lack of significant findings. However, it is not clear which intensity components were responsible for the lack of positive outcomes if indeed any of the components were responsible at all. Research which investigates the impact of intensity variables on the effectiveness of the VRG would be valuable.

4.3.3.5. Limitations of the VRG programme.

Weaknesses inherent in the VRG programme may have been the cause of the null results. Potential limitations of the VRG programme are discussed in chapter five and six.

4.4. Recommendations

Research into the effectiveness of peer-facilitated ICT-based reading programmes is ripe for investigation. To the researcher's knowledge, the original VRG study (Pascoe et al., in preparation) is the first to explore the area. Information related to whether children can successfully offer support to struggling readers during ICT-based reading programmes would be beneficial in the South African context where the proportion of children with reading difficulties is high and the body of professionals able to offer intervention services is limited (~chapter one). If such studies are found to be effective and efficient, peer-delivered literacy programmes could support a great number of learners.

It would be helpful for future research to examine the effect of learner characteristics (e.g., age, grade, sex, diagnoses, type of reading difficulty, severity of reading difficulty) on the effectiveness of the VRG programme. The prospective study described in the following chapter therefore investigated whether the VRG intervention resulted in positive intervention effects for learners with weak reading skills (a sample recruited from a school for LSEN) because some literature suggests that learners with poorer pre-test reading skills responded better to ICT-based reading intervention than those with stronger pre-test skills (Cheung & Slavin, 2011; Fogarty et al., 2017; Wise et al., 2000).

The role of the reading partner in the VRG intervention requires further investigation. Information about the impact of different reading partners (e.g., peer, sibling, parent, teacher, SLT) on VRG effectiveness could be explored. This could offer insight into who is able to provide support that results in reading gains as well as the contexts where the programme could be used. For this reason, the prospective study made use of SLT reading partners. SLT reading partners were selected due to evidence which proposed that reading outcomes are more positive when intervention is delivered by adults who have knowledge of reading development and expertise in providing reading support (Galuschka et al., 2014; Mathes & Fuchs, 1994; Scammacca et al., 2015; Suggate, 2016). The results of the prospective study are provided in chapter five.

Qualitative inquiries into learners' and reading partners' attitudes, thoughts, perceptions and feelings related to the VRG are important. This would provide information related to whether the VRG enhances learner engagement and motivation during intervention and whether modifications related to these aspects of the programme may be required. Accordingly, the prospective study had a qualitative component which examined some of these variables. The results of the qualitative undertaking are presented in chapter five.

4.5. Conclusion

The chapter has provided the results of the retrospective analysis of a portion of data collected as part of a larger intervention study. The main finding was that there were no statistically significant differences between the intervention and control groups on measures of reading at post-test. After the intervention period, participants in the intervention groups' reading accuracy, rate, vocabulary and comprehension were equivalent to those in the control group. The discussion section elaborated on studies with similar and dissimilar findings and explained possible reasons for these findings together with some recommendations for future research.

The findings of the retrospective analysis prompted the researcher to question whether alteration of the following factors would lead to more positive treatment effects: (1) the reading skill of the learners at onset (the participants in the retrospective analysis attended mainstream schools and had relatively high reading skills at pre-test; greater gains may have resulted had their reading skills been weaker, such as those of learners represented at a school for LSEN) and (2) the identity of the reading partners (it may have been more beneficial for experienced adult clinicians to offer support rather than participants' peers). Furthermore, understanding of participants' attitudes and experiences of the VRG was deemed important for a holistic inquiry into the programme. These considerations led to the development of the prospective component of the study, the results of which are presented in the following chapter.

Chapter Five

Prospective study: Results and discussion

5.1. Introduction to Chapter

Chapter five presents the findings of the prospective study in two sections. The first section provides the results and discussion for the quantitative part of the study. The results of the paired samples t-tests comparing the intervention and control groups at pre-test are presented, the independent samples t-tests for gains scores are provided, and descriptive patterns of matched participant pairs are explained. A discussion of the results, which considers possible reasons for the non-significant difference between intervention and control groups, ensues. The second section of the chapter provides the results of the qualitative component of the study and discussion thereof.

5.2. Quantitative Component

5.2.1. Results

5.2.1.1. Pre-test: Comparison between intervention and control groups.

Paired samples t-tests of pre-test raw scores on the outcome measures were completed to compare the performance of the experimental and control groups before the commencement of the VRG intervention. This was done to determine whether the groups were well-matched at pre-test and could be considered equivalent. Table 16 (Appendix D1) presents the results of the paired samples t-tests for the assessment measures and indicates that the groups were well matched on all measures except for the BPVS where a significant difference between the intervention and control group's performance at pre-test was noted. The intervention group ($M=80.11$, $SD=12.01$) outperformed the control group ($M=74.20$, $SD=18.41$) on this measure at pre-test ($p=0.0353$). The intervention group's stronger receptive vocabulary skills may have placed them at an advantage by increasing their likelihood of benefiting from the VRG intervention. However, the intervention group did not demonstrate significantly different skills to the control group on the other outcome measures. Additionally, the post-test results suggest that the initial difference in receptive vocabulary performance did not have an impact on the performance of the groups. The groups were therefore well-matched at pre-test on the majority of the outcome measures, although receptive language vocabulary matching was not optimal.

Data from one intervention participant was excluded from the post-test analysis of the BPVS because it was an outlier (extreme value). The participant's raw score on the BPVS was 87 (standard score of 89) at pre-test and substantially lower at post-test (raw score of 15 and standard score of less than 40). The participant's other scores did not differ substantially from pre- to post-test, suggesting that the

post-test performance on the BPVS was invalid and a result of a testing error (e.g., the child had reduced attention during this task). No other data was excluded from the statistical analyses conducted.

5.2.1.2. Post-test: Comparison between gain scores of intervention and control groups.

The intervention and control groups' raw score pre- and post-test means and standard deviations for the outcome measures and each group's gain score (showing the difference between pre- and post-test results) are displayed in Table 17. When interpreting the gain scores represented in Table 17, it is important to be cognisant that positive gains indicate improvement for the following outcome measures: the BPVS; the Burns and Roe reading comprehension and words per minute subtests; the TOWRE; the WIAT-II subtests of word reading, pseudoword decoding, reading comprehension and reading target words; and the VRG components of words per minute and reading comprehension. For these assessments, a higher score from pre- to post-test indicates a greater number of responses were correct or that reading speed increased. Negative gains indicate improvement for the Burns and Roe self-corrections and reading errors component; the RAN/ RAS objects and letters subtests; the WIAT-II reading speed; and the VRG measure of reading errors. For these measures a lower score indicates fewer mistakes were made, items were named faster or that passages were read faster (fewer seconds taken to complete the tasks).

It should be noted that an increase in self-corrections could be a positive gain if learners recognise and correct errors which they previously would not have noticed or been able to amend. However, a decrease in self-corrections could be considered positive if learners read words accurately the first time and therefore do not need to re-read them. With regards to reading speed, a higher words per minute reading rate can indicate more automatic decoding and an increase in fluency. In contrast, a lower rate could indicate that learners are attempting to decode challenging words rather than guessing or skipping them, which could be considered positive. Additionally, it would not be beneficial for learners to read texts faster if this was not associated with active engagement and comprehension of the material. Thus, gains for self-corrections and reading speed measures should be interpreted bearing these caveats in mind.

Table 17: Prospective study participants' pre- and post-test raw score results and the gain scores for the outcome measures

Assessment	Group	Pre-test	Post-test	Gain Score	
		M (SD)	M (SD)	M (SD)	
BPVS	Intervention	80.11 (12.01)	85.33 (6.87)	5.22 (2.84)	
	Control	74.2 (18.41)	78.2 (15.76)	4.0 (4.73)	
Burns and Roe	Comprehension	Intervention	3.55 (1.787)	5.2 (1.418)	1.65 (1.471)
		Control	4.0 (1.748)	4.5 (1.564)	0.15 (1.84)
	Words per minute	Intervention	77.8 (25.943)	69.6 (26.437)	*-8.2 (16.45)
		Control	62.2 (35.35)	72.7 (31.351)	*10.5 (14.22)
	Self-corrections	Intervention	1.90 (2.131)	1.90 (1.969)	0 (1.632)
		Control	1.8 (2.299)	2.200 (2.616)	0.4 (2.716)
	Errors	Intervention	9.7 (9.615)	4.5 (3.439)	-5.2 (8.23)
		Control	9.3 (10.446)	7.6 (6.484)	-1.7 (5.518)
RAN/RAS	Objects	Intervention	45.300 (7.944)	43.0 (7.423)	-2.3 (9.5221)
		Control	47.0 (11.869)	50.3 (15.556)	3.3 (13.76)
	Letters	Intervention	33.2 (12.025)	31.3 (8.15)	-1.9 (6.08)
		Control	33.0 (5.92)	30.1 (6.045)	-2.9 (6.78)
TOWRE sight word efficiency subtest	Intervention	53.6 (8.8719)	57.2 (9.16)	3.6 (5.89)	
	Control	48.4 (16.15)	50.8 (13.54)	2.4 (6.619)	
WIAT-II	Word reading	Intervention	91.7 (9.615)	95.000 (13.848)	3.3 (10.38)
		Control	88.2 (13.669)	90.5 (12.572)	2.3 (5.812)
	Pseudoword decoding	Intervention	18.1 (12.296)	22.2 (10.911)	4.1 (11.08)
		Control	19.5 (11.413)	21.30 (13.638)	1.8 (6.54)
	Reading comprehension	Intervention	18.1 (7.294)	20.7 (9.12)	2.6 (4.718)
		Control	19.2 (11.37)	20.7 (8.769)	1.5 (12.56)
	Reading target words	Intervention	16.0 (5.206)	18.4 (4.271)	2.4 (3.13)
		Control	15.9 (7.43)	16.5 (7.321)	0.6 (5.168)
Reading speed	Intervention	653.9 (247.489)	639.2 (428.341)	-14.7 (371.2)	
	Control	547.1 (511.959)	498.4 (235.673)	-48.7 (420.39)	
VRG baseline	Comprehension	Intervention	72.000 (19.321)	73.000 (15.670)	1 (19.690)
		Control	68.000 (26.161)	68.000 (23.475)	0.000 (14.910)
	Words per minute	Intervention	62.000 (21.898)	71.300 (23.094)	9.300 (10.520)

Errors	Control	55.300 (28.292)	67.600 (31.482)	12.300 (8.880)
	Intervention	9.600 (5.257)	7.800 (6.38)	-2.300 (4.690)
	Control	11.100 (8.130)	10 (7.702)	-1.100 (2.420)
VRG therapy level				
Comprehension	Intervention	n.a.	76.000 (18.973)	n.a.
	Control	n.a.	68.000 (28.982)	n.a.
Words per minute	Intervention	n.a.	81.500 (17.096)	n.a.
	Control	n.a.	73.100 (29.388)	n.a.
Errors	Intervention	n.a.	2.700 (2.540)	n.a.
	Control	n.a.	7.400 (6.834)	n.a.

Note. Raw scores were used. *M* refers to mean. *SD* refers to standard deviation. *BPVS* is the British Picture Vocabulary Scale. *Burns and Roe* is the Burns and Roe Informal Reading Inventory – 8th edition. *RAN/RAS* is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. *TOWRE* is the Test of Word Reading Efficiency. *WIAT-II* is the Wechsler Individual Achievement Test – 2nd edition. *VRG* refers to the in-built assessment measures on the Virtual Reading Gym online programme. Noteworthy results have been highlighted. Significant results have been indicated with an asterisk (*).

Independent samples t-tests were conducted to determine whether there was a significant difference between the raw score gains made by intervention and control groups on completion of the VRG intervention programme. The results are presented in Table 18 (Appendix D2). The results of the independent samples t-tests indicated that (1) there was a small but statistically significant difference between the gains made by the intervention and control groups on the Burns and Roe words per minute measure ($p=0.014$); (2) the difference between the gains made by the intervention and control groups on the Burns and Roe reading comprehension measure was approximating significance ($p=0.05$); and (3) there were no statistically significant differences between the gains made by intervention and control groups on the rest of the outcome measures ($p>.05$).

There was a statistically significant difference in intervention and control group participants' gain scores on the Burns and Roe words per minute measure as a result of intervention learners showing a decrease in the number of words read per minute from pre- to post-test ($M=-8.20$, $SD=16.45$) and learners in the control group showing an increase in the number of words read per minute from pre- to post-test ($M=10.5$, $SD=14.22$). Thus, intervention learners read more slowly while the control learners read faster. The effect size of the difference was marginal (Cohen's $d=0.121$). Although the control group read faster, this was not associated with making fewer reading errors (on the Burns and Roe) than the intervention group; in fact, intervention learners' reading error scores decreased more from pre- to post-test ($M=-5.20$, $SD=8.23$) than control learners' ($M=-1.7$, $SD=5.51$). Moreover, the control group's increase in reading speed was not accompanied by greater text comprehension (on the Burns and Roe) than the intervention group. The intervention group actually showed greater reading comprehension gains ($M=1.65$, $SD=1.47$) than the control group ($M=0.15$, $SD=1.84$) from pre- to post-test. Subsequently, the control group's increase in reading speed did result in a reading accuracy

or comprehension advantage. Rather, the intervention group's decrease in reading speed was associated with higher accuracy and comprehension scores, suggesting that their reduction in pace may have been beneficial and should not necessarily be interpreted as a negative result. Interestingly, the control group did not show greater reading speed increases than the intervention group on the other assessment measures that recorded reading speed (WIAT-II and VRG). This could indicate that the Burns and Roe is a sensitive measure of reading speed.

The difference between the gains made by the intervention and control groups on the Burns and Roe reading comprehension measure was approximating statistical significance ($p=0.05$) as a result of the intervention group having a higher gain in score ($M=1.65$, $SD=1.47$) than the control group ($M=0.15$, $SD=1.84$). It is possible that statistical significance would have been reached had a larger sample size been used (as small sample sizes undermine statistical power). This finding suggests that it is possible that the VRG intervention improved learners' reading comprehension skills. However, the intervention group did not show an advantage over the control group on the other comprehension measures (WIAT-II and VRG), suggesting the Burns and Roe may be more sensitive to subtle comprehension improvements than the other tests.

The gain score results from pre- to post-test did not reach statistical significance on most of the outcome measures. Nevertheless, there were some trends in the data. From pre- to post-test, both the intervention and control groups improved on most measures. The intervention group improved on all measures of reading accuracy, naming speed, receptive vocabulary and reading comprehension as well as most measures of reading rate. The control group improved on all measures of reading accuracy, comprehension, rate and receptive vocabulary, yet they showed poorer naming speed (the RAN/ RAS objects subtest) and an increase in self-corrections (which could be interpreted as a gain or loss) at post-test. Participants' poorer post-test performance on certain measures could reflect random error and natural variation in test performance rather than skill regression. As both the intervention and control groups improved on the majority of assessment measures, the literacy gains were likely related to typical developmental progression and classroom instruction (Tredoux & Smith, 2013).

There was a statistically significant difference between the experimental and control groups' performance on the BPVS at pre-test. However, both groups performed closely at post-test (intervention group $M=85.33$, $SD=6.87$ and control group $M=78.2$, $SD=15.76$) and there was no statistically significant difference between the groups' gain scores at post-test ($p=0.789$). Thus, findings were not influenced by the groups' lack of equivalence on these measures at pre-test.

5.2.1.3. Post-test: Comparison of intervention and control group on VRG therapy level measure.

At post-test, the intervention and control groups were assessed on a VRG internal assessment at the level at which therapy occurred. Each intervention participant completed VRG at the level which the initial assessment showed would be appropriate for their reading abilities. At post-test, the intervention learners were assessed on the same level which they had been working on VRG. The control learners were assessed on the same level which their matched intervention participant had been working on. The VRG therapy level outcome measures were conducted with the intervention and control groups at post-test only; there were no pre-test scores for these measures.

Independent sample t-tests were conducted to determine whether there was a statistically significant difference between the performance of the intervention and control groups at post-test on the VRG therapy level outcome measures (Table 19). There was no statistically significant difference between the intervention and control groups on the VRG comprehension, words per minute and reading errors measures ($p > .05$). However, the reading errors measure was approximating significance ($p = 0.056$). It is possible that statistical significance would have been reached had a larger sample size been used. At post-test, the intervention learners' reading accuracy on the VRG therapy level reading passages was higher than that of the control learners', as the intervention learners made fewer reading errors than the controls. This finding suggests that the VRG programme may have resulted in an increase in participants' reading accuracy for passages that were at the same level as the level at which intervention had been provided. This result should be interpreted with caution, as it is unknown whether the intervention and control groups were equivalent at pre-test and the VRG measures are not standardised. Nevertheless, it is possible that the VRG therapy resulted in the superior reading accuracy skills of the intervention participants on the internal VRG reading error measure.

Table 19: Prospective study independent samples t-test results for the VRG therapy level outcome measures

Assessment	t	df	Sig. (2 tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
						Lower	Upper
VRG therapy level							
Comprehension	0.730	18	0.474	8.000	10.954	-15.010	31.010
Words per minute	0.781	18	0.444	8.40	10.751	-14.190	30.990
Errors	2.038	18	0.056	-4.700	2.306	-9.540	0.140

Note. Raw score outcome measure results were used. *t* is the test statistic. *df* is the degrees of freedom. *Sig (2 tailed)* is the *p*-value corresponding to the given test statistic and degrees of freedom. Mean difference is the difference between the sample means. Std. error difference is the standard error. VRG refers to the in-built assessment measures on the Virtual Reading Gym online programme. Results which are discussed further in the text have been highlighted.

5.2.1.4. Descriptive patterns of matched pairs.

As was done for the retrospective analysis, the prospective study data were analysed descriptively to look for patterns in the data for each matched pair. Raw score average gains (the mean of the pre- to post-test increases and decreases for each assessment) were calculated for the intervention and control participants in each pair. Because positive and negative gains reflected different progress for different measures, the researcher represented all scores indicative of improvement from pre- to post-test as positive and all scores indicative of a decrease in skill as negative. Dyads were grouped into one of four categories: (1) intervention participant outperforms control participant, (2) control participant outperforms intervention participant, (3) similar performance (difference between average score gains of less than two raw score points), and (4) decrease in performance for intervention and control participants. There were four dyads in category one, three dyads in category two, one dyad in category three and one dyad in category four. An example of a dyad from each category is provided below.

Category 1: Intervention outperforms control.

Participant S (intervention) and participant T (control) are an example of a dyad where the intervention learner outperformed the matched control learner from pre- to post-test. Child S showed greater improvements than child T on nine of the assessment measures, child T showed greater improvements than child S on four of the assessment measures and they performed similarly (improved by the same number of points/ no improvement/ both decreased) on three of the assessments. Child S improved by an average of 16.87 points from pre- to post-test and child T declined by an average of -25 points from commencement to study completion. Their average gain

scores differed by 41.87 points. The intervention learner in the pair thus showed an advantage over the matched control.

Category 2: Control outperforms intervention.

Child M (intervention) and N (control) are an example of a participant pair where the control learner performed better from pre- to post-test than the intervention learner. Child M improved more than child N on two of the outcome measures, child N improved more than child M on twelve of the outcome measures, and they performed similarly on two of the assessments. Child M improved by an average of 25.68 raw score points. On the other hand, child N improved by an average of 58.62 raw score points, 32.93 points higher than child M. Therefore, the control learner improved to a greater extent than the intervention learner.

Category 3: Intervention and control with similar performance.

A dyad illustrative of similar gain performance after study completion are participant Q (intervention) and R (control). Each learner achieved higher average gain scores than the other for five outcome measures and they performed equivalently on six of the assessments. Participant Q gained an average of 8.37 points over the course of the study and participant R gained an average of 9.37 points. The difference in their average gain scores was thus only 1.37 raw score points, indicating that they both performed similarly from the start to the end of the VRG intervention period.

Category 4: Intervention and control decline in performance.

There was only one participant pair where both learners had an average score decline from pre- to post-test. Participants O (intervention) and P (control) formed such a dyad. Participant O outperformed participant P on five assessments, participant P outperformed participant O on five assessments, and they performed similarly on six of the outcome measures. Child O had an average of a -2.09 raw score decrease per assessment from pre-intervention to post-intervention. Child P had an average of a -24.18 score decrease per assessment over the course of the study. They therefore both had poorer skills at post-test than pre-test. However, child P (the control) decreased by a greater number of points than child O (intervention).

Dyads trends summary.

Performance across the categories suggests that, overall, intervention participants' improvements were not superior to that of their matched controls after the intervention period. Analysis of the prospective study data with quantitative measures (parametric tests comparing the intervention and control groups) and descriptive methods (average gain scores within matched participant pairs)

reveals the common finding that intervention and control participants' reading skills were not significantly different from each other at the end of the VRG programme.

5.2.2. Discussion

The aim of the prospective study was to determine the effectiveness of SLT-delivered VRG intervention for grade three to six learners with reading difficulties from a school for LSEN. The objective was to describe changes in learners' reading (accuracy, rate, vocabulary and comprehension) after VRG intervention. The main findings were that (1) there was a statistically significant difference between the gains made by the intervention and control groups on the Burns and Roe words per minute measure (the control group's reading speed increased and the intervention group's reading speed decreased from pre- to post-test); (2) the difference between the gains made by the intervention and control groups on the Burns and Roe reading comprehension measure was approximating significance (the intervention group showed a greater improvement than the control group); (3) reading accuracy on the post-test VRG therapy level measure of reading errors was approximating significance (the intervention group showed fewer word reading errors than the control group); and (4) there were no statistically significant differences between the gains made by intervention and control groups on the remainder of the outcome measures. The trends in participant dyads showed that, in general, intervention learners did not show a clear advantage over their matched controls after participation in the VRG programme.

In summary, there is evidence to suggest that the VRG intervention may have resulted in some degree of reading accuracy and comprehension improvements for grade three to six learners with reading difficulties from a school for LSEN. There was no evidence to suggest that the VRG programme resulted in receptive vocabulary gains. The impact of the VRG intervention on reading rate was not clear, as intervention learners' reading rate decreased significantly on one measure of reading speed but did not change significantly on other reading speed measures.

5.2.2.1. Comparison to retrospective analysis.

The main findings of the retrospective analysis (chapter four) and the prospective study are the same. The retrospective analysis explored the effectiveness of peer-delivered VRG intervention for grade three to six learners with reading difficulties from mainstream schools; the prospective study evaluated the effectiveness of SLT-delivered VRG intervention for grade three to six learners with reading difficulties from a school for LSEN. The retrospective analysis showed no statistically significant differences between the intervention and control groups at post-test but the gain score for the Burns and Roe self-correction measure was approximating significance (the intervention learners made fewer self-corrections and the control children made more). This could suggest some degree of reading accuracy improvement due to the VRG intervention. Similar to the retrospective analysis, few

significant differences were found for most of the prospective study outcome measures when control and intervention groups were compared. However, some limited evidence suggests the VRG intervention had an impact on reading rate, accuracy and comprehension. Both the retrospective analysis and the prospective study showed performance trends which indicated that all participants (intervention and control) made reading skill progress over time.

5.2.2.2. Comparison to other studies.

The similarities and differences of the retrospective analysis findings to other ICT-based reading intervention studies was discussed in chapter four. Seeing as the results of the prospective study are closely related to the results of the retrospective analysis, the discussion in chapter four can be applied to the prospective results. The comparison of the retrospective analysis and prospective study findings to related literature will be further explored in chapter six.

5.2.2.3. Possible reasons for the non-significant results.

The non-significant results of the prospective study (reflected by the majority of the reading skill measures) may be related to the factors of the learners' age and grade, the VRG intervention intensity, the learners' diagnoses, and weaknesses of the VRG programme. The discussion of the factors of age and grade as well as intervention intensity which were presented in chapter four apply to the prospective study as well. Possible contributions of the learners' diagnoses and limitations of the VRG programme will be discussed in the sections which follow.

Participants' diagnoses.

At the completion of the retrospective analysis, the researcher hypothesised that the peer-mediated VRG intervention may have been more effective had the learners had weaker reading skills at the onset of the study because some research has shown that ICT-based reading intervention resulted in greater gains for learners with lower pre-test academic and reading abilities (Cheung & Slavin, 2011; Fogarty et al., 2017; Wise et al., 2000). Thus, participants in the prospective study were recruited from a school for LSEN. There were learners with the diagnoses of SLD, HL, ASD, ADHD and PD. Their pre-test reading skills were lower than the participants in the retrospective analysis. Although the variable of participant academic and reading ability was deliberately manipulated for the prospective study to determine whether it would lead to more positive results, the learners' diagnoses may have been one of the factors which contributed to the null results.

Studies have shown that children with diagnoses such as those outlined above tend to have weaker reading skills than children without these diagnoses (Åsberg & Sandberg, 2012; Brown, Oram-Cardy, & Johnson, 2013; Chard, Ketterlin-Geller, Baker, Goabler, & Apichatabutra, 2009; Compton, Fuchs, Fuchs, Lambert, & Hamlett, 2012; Harris & Terlektsi, 2010; Harris, Terlektsi, & Kyle, 2017; Larsson, Sandberg, & Smith, 2009; Lederberg, Schick, & Spencer, 2012; Lucas & Norbury, 2014; Paloyelis,

Rijsdijk, Wood, Asherson, & Kuntsi, 2010; Park, Lombardino, & Ritter, 2013; Peeters, Verhoeven, de Moor, & van Balkom, 2009; Moran et al., 2008; Sexton, Gelhorn, Bell, & Classi, 2011; Worsfold, Mahon, Pimperton, Stevenson, & Kennedy, 2018; El Zein et al., 2016; El Zein, Solis, Vaughn, & McCulley, 2014). Yet, to date there are few studies which have investigated differential responses of learners to ICT-based reading interventions. Prospective study participants were likely at the LSEN school because they had not made expected progress in academic and/ or reading skills and had shown poor response to intervention and thus required the intensive support offered at the school (Ardoin, Witt, Connell, & Koenig, 2005; Greenfield, Rinaldi, Proctor, & Cardarelli, 2010; Justice, 2006; Sanger, Mohling, & Stremlau, 2012a; Sanger, Snow, Colburn, Gergen, & Ruf, 2012b). Therefore, it is plausible that one of the reasons participants did not show statistically significant VRG-related improvements may have been because of their learning difficulties and medical diagnoses.

Studies examining the variable of initial reading skill in learner response to reading intervention exist. For example, Torgesen (2000) reviewed studies related to how well learners in the foundation grades of primary school responded to intervention and found that learners with the lowest pre-test reading-related skills showed the least growth in word reading skills. The National Reading Panel (2000) found that (1) phonological awareness programmes, (2) phonics programmes, and (3) fluency programmes were less effective for learners classified as reading disabled than for learners at-risk for reading difficulties and normally progressing learners. Likewise, a meta-analysis by Galushka et al (2014) showed that children and adolescents with more severely impaired reading disabilities showed less improvement in literacy skills after intervention than learners with milder reading disabilities. Therefore, some evidence exists that learners with weaker reading skills do not respond as well to reading intervention as those with less severe difficulties. However, studies with the opposite finding (weak readers responding better than strong readers) exist as well (Cheung & Slavin, 2011; Fogarty et al., 2017; Wise et al., 2000). Overall, it is possible that learners in the prospective study did not show significant reading gains because they represent a group that tends to show limited response to reading intervention.

Potential weaknesses of the VRG programme.

The VRG programme's strengths and theoretical underpinnings were explored in chapter two. In this section, potential weaknesses of the programme will be discussed. The retrospective analysis and the prospective study may not have found positive intervention effects due to shortcomings of the VRG intervention. Factors such as intervention not being specific to learners' patterns of reading difficulties, no phonological awareness training, no systematic or synthetic phonics provision, the number of exemplar words used to target phonics patterns, vocabulary instruction limitations, the lack

of reading comprehension strategy and oral language targets, and fluency work not offering certain key practice opportunities will be considered.

Intervention not specific to children's core reading deficits.

The VRG's inbuilt initial assessment ensures that learners begin intervention at an appropriate level and the programme enables learners' own unique word reading errors to be practised. However, a limitation of the VRG may be that the programme does not fully consider learners' unique profile of reading deficits. For example, all learners read passages (which can be repeated up to three times), answer three comprehension questions after the final reading of the passage, and complete pattern and vocabulary card activities (~chapter two). Children with phonologically-based reading deficits do not necessarily spend more time focussed on phonics-related tasks, children with fluency-based deficits do not inevitably receive more opportunity to read passages repeatedly, and learners with vocabulary and reading comprehension fallouts do not gain more language- and metacognitive-related input. Regardless of whether learners have one main area of reading weakness or a multicomponent reading difficulty, the intervention the VRG offers remains relatively consistent.

Gough and Tunmer's simple view of reading (1986) was used to classify learners from the prospective study into one of four reading profiles: (1) good word reading and good reading comprehension, (2) good word reading and poor reading comprehension, (3) poor word reading and good reading comprehension and (4) poor word reading and poor reading comprehension. Learners were classified as having poor word reading if they obtained a standard score of 84 or less on two or all three of the following pre-test measures: (a) the TOWRE sight word reading efficiency subtest, (b) the WIAT-II word reading subtest, and the (c) WIAT-II pseudoword decoding subtest. Learners were classified as having poor reading comprehension if they obtained a standard score of 84 or less on one or both of the pre-test measures of: (a) the BPVS and (b) the WIAT-II reading comprehension subtest. Table 20 shows how the prospective study participants fall into the four categories.

Wolf and Bower's double deficit hypothesis (1999) was used to subtype learners as having one of three reading deficits: (1) a phonological deficit, (2) a fluency deficit or (3) a phonological and fluency deficit. Learners were classified as having a phonological deficit if they had a standard score of 84 or less on the pre-test WIAT-II pseudoword decoding subtest. Learners were subtyped as having a fluency deficit if they had a standard score of 84 or less on two or all three of the following pre-test measures: (a) the RAN/RAS objects subtest, (b) the RAN/RAS letters subtest and (c) the reading speed measure of the WIAT-II. Table 20 also includes the results of this classification process.

There were the following reading skill profiles: (1) Category one - one participant with good word reading and good reading comprehension (who had a fluency deficit); (2) Category two - three participants with good word reading and poor reading comprehension (with one having a fluency

deficit and the other two having no additional deficits); (3) Category three - three participants with poor word reading and good reading comprehension (with all three having a phonological deficit); and (4) Category four - thirteen participants with poor word reading and poor reading comprehension (one with a fluency deficit, four with a phonological deficit and eight with a phonological and fluency deficit).

Table 20: Prospective study participants' reading skill profiles at pre-test.

Participant	Randomisation	Reading Skill Profile			
		Category 1: Good word reading & good comprehension	Category 2: Good word reading & poor comprehension	Category 3: Poor word reading & good comprehension	Category 4: Poor word reading & poor comprehension
A	Intervention				X (with phonological deficit)
B	Control				X (with fluency deficit)
C	Intervention			X (with phonological deficit)	
D	Control			X (with phonological deficit)	
E	Intervention		X (with no additional deficit)		
F	Control	X (with fluency deficit)			
G	Intervention				X (with phonological & fluency deficit)
H	Control				X (with phonological & fluency deficit)
I	Intervention				X (with phonological & fluency deficit)
J	Control				X (with phonological & fluency deficit)
K	Intervention		X (with fluency deficit)		
L	Control		X (with no additional deficit)		
M	Intervention				X (with phonological deficit)
N	Control				X (with phonological & fluency deficit)
O	Intervention				X (with phonological deficit)
P	Control			X (with phonological deficit)	
Q	Intervention				X (with phonological & fluency deficit)
R	Control				X (with phonological & fluency deficit)
S	Intervention				X (with phonological deficit)
T	Control				X (with phonological & fluency deficit)

Classifying intervention participants according to their reading difficulties showed that participants may have benefited from intervention focussing primarily on the following:

- Participants A, M, O, & S: word reading, reading comprehension and phonological skills
- Participant C: word reading and phonological skills

- Participant E: reading comprehension skills
- Participant G, I, & Q: word reading, reading comprehension, phonological and fluency skills
- Participant K: reading comprehension and fluency skills

The process of profiling participants revealed that the intervention learners had different patterns of reading strengths and weaknesses. The SLT reading partners were provided with information related to intervention participants' pre-test results so that they could offer appropriate support during VRG intervention. However, it is possible that the results of the intervention may have been more successful if the VRG contained more inbuilt processes ensuring learners' core reading weaknesses were targeted or if training of reading partners (related to how to use the VRG as a tool to target the child's unique reading challenges) were a key component of the programme.

No phonological awareness.

Phonological awareness could mistakenly be thought of as a skill which should only be targeted in younger learners because it forms an essential component of evidence-based literacy instruction in preschool to grade two classrooms (Gillon, 2017; National Reading Panel, 2000; Schuele & Boudreau, 2008). However, phonological awareness intervention is important for older struggling readers with phonological deficits, as it can bring about significant improvements in word reading and decoding (Duff & Clarke, 2011; Gillon & McNeill, 2009; Gillon, 2017; Goldsworthy, 2003; Muter, 2006; National Reading Panel, 2000; Snowling & Hulme, 2011). Classifying the prospective study participants based on pre-test performance on the decoding outcome measure showed that the majority of the learners had phonological deficits. They therefore would have benefited from structured, explicit phonological awareness skill training as well as its application to reading tasks (Duff & Clarke, 2011; Gillon, 2017; Goldsworthy, 2003; National Reading Panel, 2000; Schuele & Boudreau, 2008). Thus, one of the limitations of the VRG programme is that it does not target phonological awareness skills. If the programme had included phonological awareness targets, it is possible that the study results may have been more positive. Alternatively, if the VRG had been used as a supplement to other forms of phonological awareness intervention, treatment effects may have been more apparent.

No systematic, synthetic phonics.

The VRG programme includes phonics instruction. Some phonic patterns (grapheme-phoneme correspondences) which children show difficulty with (read incorrectly) in passage reading are subsequently practiced in isolation and in words. Additionally, the reading partner can select phonic patterns with which the child struggles to be added to the store of patterns to be practiced. This approach to phonics may not be optimal for producing reading gains, however. Evidence suggests that

systematic, synthetic phonics (which refers to teaching grapheme-phoneme correspondences in a well-defined, graded sequence and the application of these skills to reading activities) results in improvements in word reading skills for children with reading difficulties (Duff & Clarke, 2011; National Reading Panel, 2000; Rose, 2006; Rowe, 2005). Consequently, one of the potential limitations of the VRG phonic activities is that it does not target grapheme-phoneme correspondences in a predetermined, incremental order. A further possibility is that the results may have been more positive if the VRG had been used as a supplement to other forms of phonics instruction. Moreover, reading gains associated with intervention may have been observed if pre-test results had been used to form an inventory of each intervention participant's gaps in phonics knowledge and if these grapheme-phoneme units had been added to each learner's VRG account in a developmentally appropriate sequence.

Limited exemplar words containing each phonic pattern.

A potential shortcoming of the VRG may be that there are insufficient exemplar words for each phonic pattern. During passage reading, words read incorrectly can be selected for further practise. If a word is selected for practise, the word and the phonic patterns within the word are displayed along with three exemplar words for each of the phonic patterns. The exemplar words contain the same phonic pattern as the original error word. The child is instructed to read the word, the sound (phonic pattern) and the exemplar words. Each time the word is practised during passage reading (a passage can be read a maximum of three times and thus an error word from the passage can be practised a maximum of three times), the same three exemplar words are provided. In the pattern cards activity, each phonic pattern (e.g. "oo") is displayed with an exemplar word (e.g. "book"). Each time the pattern cards activity is completed, the exemplar for each pattern is the same. During this activity, patterns can be selected for additional practise which results in a grid of eight words (each containing the pattern) being displayed for the child to read. Every time a pattern is selected for additional practise during the pattern cards activity, the same eight words are presented. In summary, there are a total of thirteen exemplar words associated with each pattern which may be practised. However, depending on which additional practise options the reading partner selects, a child may be exposed to either one, four, nine, or thirteen of the exemplar words. This may be an insufficient number of practice words to result in generalisation of the pattern to allow new, unpractised words containing the pattern to be read correctly. The number of exemplar words required to promote transfer of phonics knowledge to novel words is not apparent, as the ICT-based reading intervention studies (analysed in chapter two) which showed treatment effects did not report on the number of practice words they contained.

No vocabulary learning strategies.

The VRG provides children with the opportunity to learn the meaning of specific target words in activities involving definitions (semantics), syllable structure (phonology), usage in sentences (syntax) and spelling (orthography). Nonetheless, one limitation of the vocabulary intervention offered by the VRG is that it does not explicitly provide word-learning strategy instruction. Examples of word-learning strategies include those which teach children how to understand the meaning of words through context, through word parts (e.g., inflections, prefixes, suffixes and roots) and by using a dictionary (Biemiller, 2010; Graves, 2007, 2016; Harmon, Hedrick, & Wood, 2005). Explicit instruction of these strategies has been linked to vocabulary growth (Biemiller, 2010; Graves, 2007, 2016; Harmon et al., 2005). Thus, vocabulary improvements may not have been associated with VRG intervention because of the programme's lack of direct word-learning technique instruction. Likewise, vocabulary gains may have been found had the VRG been combined with specific reading partner training related to how to teach children vocabulary-learning strategies during the programme.

Reading comprehension limitations.

The VRG has two components aimed to improve reading comprehension skills, namely vocabulary activities and the answering of questions after each passage has been read. Reading partners can use the programme as a tool to foster other reading comprehension skills (e.g., the timer can be paused during passage reading for discussion to occur) but these opportunities are not explicit, in-built components of the VRG programme. Literature examining the skill profiles of children with reading comprehension difficulties has found they can have weaknesses in oral receptive and expressive language (e.g., vocabulary, grammar, narrative production and listening comprehension); comprehension monitoring; figurative language; making inferences; and verbal working memory (Clarke, Snowling, Truelove, & Hulme, 2010; Duff & Clarke, 2011; Nation & Angell, 2006; Snowling & Hulme, 2011). Thus, interventions which have been shown to improve learners' reading comprehension skills have targeted language skills (vocabulary, grammar, narrative production, elements of story structure, listening comprehension, figurative language and making inferences); metacognitive and reading comprehension strategies or a combination of both language and metacognitive/ strategy areas (Burke et al., 2008; Camahalan, 2006; Cebe & Paour, 2000; Clarke et al., 2010; Duff & Clarke, 2011; Edmonds et al., 2009; Eilers & Pinkley, 2006; Elleman & Compton, 2017; Gibson, 2009; Haddad et al., 2003; Kim et al., 2006; Klapwijk, 2012; Moonsamy, 2011; Nation & Angell, 2006; Nation, 2006; National Reading Panel, 2000; Ness, 2009; Pressley, 2000; Scharlach, 2008; Snowling & Hulme, 2011; Ukrainetz, 2017). Examples of effective metacognitive reading comprehension strategies include prediction, activating background knowledge, visualisation, visual representation, comprehension monitoring, thinking aloud, asking questions, answering questions, summarising, and vocabulary (National Reading Panel, 2000; Connor et al., 2004; Nation & Angell,

2006; Burke et al., 2008; Scharlach, 2008; Zimmerman & Hutchins, 2003). For children to use reading comprehension strategies when encountering novel texts, they require explicit instruction of how to use the strategies, scaffolding from teachers and repeated opportunities to practice using the strategies (Scharlach, 2008; Ukrainetz, 2017). Therefore, a shortcoming of the VRG is that it does not contain in-built opportunities for learners to be taught reading comprehension strategies or activities to boost language skills (other than vocabulary). These may be factors related to the finding that participants' reading comprehension skills did not increase significantly after VRG intervention. Like the other components of the VRG, more positive reading comprehension results may have been found if the VRG had been used as a supplement to other reading comprehension intervention or if reading partners had been trained how to use the VRG to improve language skills and provide explicit instruction of comprehension strategies.

Fluency limitations.

The VRG uses the activity of repeated reading of text passages in an attempt to improve learners' reading fluency skills. Reading partners can control whether learners read a passage once, twice or three times. Reading partners provide feedback (e.g. model of the correct production of each word produced in error) while the learner reads the passage. Repeated reading and the provision of feedback related to accuracy are evidence-based techniques for improving learners' reading fluency skills (Chard et al., 2002; Lee & Yoon, 2017; National Reading Panel, 2000; Stevens, Walker, & Vaughn, 2017; Therrien, 2004). Seeing as the VRG intervention did not result in significant fluency gains, it is possible that certain important fluency-facilitating activities are missing from the programme. Literature suggests that, for the most significant improvements in fluency and comprehension, learners should first be given the opportunity to listen to an adult model fluent reading of the passage, learners should be asked to read at an appropriate speed and with the purpose of understanding the material, passages should be read by the learner three to four times, performance criteria should be set (the child should aim to read at a specific speed and word accuracy level) and learners should be given corrective feedback for words read in error (Chard et al., 2002; Lee & Yoon, 2017; Stevens et al., 2017; Therrien, 2004). The intervention participants' reading fluency may have shown more improvement had a greater number of these fluency-facilitating activities been included in the VRG intervention.

5.2.3. Recommendations

Future research should investigate whether alternate study designs, such as those with greater sample sizes and higher intervention intensity, produce positive VRG intervention results. Evaluating whether the VRG programme is more effective when learners are provided with differential treatment based on their core reading deficits would be valuable as well. If such undertakings are not fruitful, the developers of the VRG may need to consider whether the programme has inherent flaws which would

require changes to be made to the VRG. Examples of adaptations to the VRG which may need to be made for the programme to promote reading skill development are provided in chapter six (~6.8.).

5.3. Qualitative Component - Thematic analysis: Results and discussion

5.3.1. Introduction to Thematic Analysis

This section of the chapter describes the findings of the qualitative component of the study. The purpose was to describe learners' attitudes (thoughts and feelings) towards the VRG and their intervention experiences. Participants in the intervention group were individually interviewed by the researcher once the VRG programme was complete. The transcribed semi-structured interviews were examined using thematic analysis.

5.3.2. Results

Four themes emerged which captured the important and relevant patterns in the data set as well as answered the aim of the qualitative undertaking. The themes were: (1) enjoyment of the VRG and intervention experiences, (2) value of the reading partners, (3) skill and self-competency gains in literacy, and (4) the programme's power to change attitudes and skills. Each theme will be described and explored below.

5.3.2.1. Theme 1: Enjoyment.

The theme "enjoyment" refers to the children perceiving the VRG and their intervention experiences as pleasant and enjoyable. The theme portrays the learners' positive attitudes towards the programme, their appraisal of the VRG and the reading partners as being "fun", their enjoyment of the environmental theme of the VRG and how they liked completing the VRG tasks.

The majority (9/10) of the learners reported that using the VRG was a positive experience. For example, child M said, "It was a very good experience" and child Q stated, "It was a positive experience for me." Half (5/10) of the learners explicitly described the programme and having a reading partner as being fun. Child S reported, "It [having a reading partner] was fun" and, "Ah, it [the VRG] was fun." When referring to having his reading partner with him during the programme participant I said, "It...was fun...it was nice." Similarly, child M explained, "...it's [the VRG] a very fun experience because you...learn to say all these different words..."

A proportion (5/10) of the learners reported enjoying the reward-based environmental theme of the VRG, such as gaining leaves (points), the city changing (e.g. reduction of pollution), and learning about looking after the environment. Learner G stated that one of his highlights of the experience was

“the city” and how “...we got some little flowers and bird thing...a road, chairs, um, a sign, and bird houses and flower pots and...some of the smoke is gone and a lot of things have changed.” Child C expressed that what he particularly liked about the VRG was “...when you get the leaves...it helps your city” and “...learning about...saving electricity.” Lastly, most (6/10) learners reported that they enjoyed the VRG tasks. For example, when referring to completing the activities participant S said, “...I like, I enjoy it.” Learner I declared, “...I love the questions.” Child O stated, “...what I like about it is mostly the stories.” Learners commented on being fond of tasks focusing on word reading, passage reading, question answering, vocabulary, phonics, and fluency.

5.3.2.2. Theme 2: Value of reading partners.

This theme relates to the participants perceiving the role of the SLT reading partners as important and valuable. The theme captures the learners’ positive attitudes towards their partners, their belief that the reading support and teaching received from their partners was helpful and the sociopsychological benefits of engaging in the programme with another individual present.

All (10/10) of the learners expressed positive attitudes towards their reading partners. For example, child A said, “It [having a reading partner] was really good”, learner Q stated, “...it [having a reading partner] was great” and participant M stated, “I like my reading buddy.” All of the children felt that the reading partners provided beneficial assistance. Learner K declared, “It [having a reading partner] was helpful.”

The participants reported receiving support from their reading partners with word reading, vocabulary, comprehension and fluency. Child C explained, “...when you read a wrong word, she taps it and then afterwards...she will try help you get it right and you’ll learn about what the word means...how to say it properly, to pronounce it.” Child Q stated, “...she helped me understand some words”, child E expressed, “...we did one [story] with a flower, and I didn’t know what an orchid looked like...so she showed me how it looks”, child G said, “...she explains about the story” and child O said, “...every time I read fast then she goes [claps twice]...to slow me down a bit so I can read it a bit - so I could read it without making mistakes.”

A few (3/10) children discussed the social and psychological value of reading with a supportive adult. Child K said it “was nice” having a reading partner because, “...she doesn’t...tell you that you must get things right. She says it’s okay if you don’t. And she says if you don’t know something you can just say you don’t know.” Child K appreciated the reading partner’s acceptance of errors and that there was no negativity or judgement involved in acknowledging a lack of ability. When asked why he liked having a reading partner child G said, “Because I always want to read to someone” which shows that he treasured the presence of another individual. Child O explained that what he liked about

having a reading partner was, “She will always laugh if you laugh. Sometimes the stories are funny.” This indicates that he enjoyed having someone to share in his joys while reading.

5.3.2.3. Theme 3: Literacy skill and self-competency gains.

The third theme represents how the learners believed that their reading, spelling and written expression improved as a result of the VRG intervention and how their perceived skill development resulted in increased feelings of self-competence and confidence.

All (10/10) of the intervention learners expressed the belief that the programme lead to improvements in their reading skills. Different participants experienced gains in different aspects of their reading. Skills reported to have improved included phonics (phoneme-grapheme associations), word reading accuracy, rate, tracking (e.g. decrease in skipping words and lines), vocabulary and reading comprehension. Child C stated that the main aspect of his reading which had improved was, “Pronouncing...learning new sounds...letters”, indicating phonics and decoding gains. Participant M experienced vocabulary improvements and stated, “...it helped me to understand words and meanings of the words.” Passage and comprehension question improvements were also experienced by child M who said, “...it helped me to understand what people are saying and what they are asking.”

In the interviews, learners were not asked any questions related to whether they thought the VRG intervention improved their written or spelling skills. However, some (4/10) of the learners volunteered the information that they believed the programme improved their written language and spelling skills. Child C revealed how he felt the programme improved his performance in English (the subject) at school and the positive impact of the intervention on his written expression and spelling. He said, “...it helped me in...English...when I’m writing stories...I’m doing quite well and my spelling’s gone up a lot.” Participant S said the programme helped “...with my spelling”, just like participant E who said that as a result of the intervention she felt, “I know how to spell more.” A final example is of child A who stated, “It [syllable work during intervention] improved...for me to spell...”

Responses from several (4/10) learners suggest that their literacy self-competence and confidence increased as a result of the intervention. Child I said, “...they told me that I was skipping lines and I felt better that I stopped, that I was starting to not skip lines...I started to read well as well.” This excerpt reveals how the learner was pleased that the programme reduced his habit of skipping lines. The words “I started to read well” suggest that he did not consider himself a good reader before the programme and that, due to the intervention, his perception of his own reading abilities improved. Child O disclosed, “That is why I took the lessons, because I had bad reading...Now, I’m good at reading.” This extract shows how the learner’s concept of himself as a reader changed from seeing himself as a “bad” reader to seeing himself as a “good” reader.

5.3.2.4. Theme 4: Power to change.

The last theme refers to how the programme changed learners' attitudes towards reading and their reading behaviours as well as their feeling that the programme could improve the reading skills of other children with reading difficulties.

The majority (9/10) of the learners said that they would recommend the VRG to a friend and expressed the belief that the programme could improve children's reading skills. For example, child C stated, "I would recommend it because, if someone really struggles it will help..." Child A demonstrated that she thought the in-built repeated practice could improve others' reading skills when she said, "I think that it would help my friend for the reading. So...gets practice...they don't know how to spell or read it but then they can read it over then, until they get it right." Moreover, child Q and E referred to their belief that the VRG can improve vocabulary and reading comprehension. Child Q said, "...I believe it will help them understand more..."; while learner E said, "It helped me and it will also help them" and it would be beneficial to those who "...do know how to read, it's just...they don't know how to understand words."

A few (2/10) of the learners' attitudes towards reading and reading behaviour changed as a consequence of the VRG intervention. Learner E explained how she had a slightly increased enjoyment of reading because of the programme which encouraged her to begin reading books at home for leisure. Child I's attitude towards reading became slightly more positive as the programme progressed. At the beginning of the interview with the researcher, learner I said, "...I didn't like the reading..." He explained that he did not enjoy the word reading tasks during the VRG intervention because "...it felt hard." However, at the end of the interview he reported, "...I was happy that day [during the intervention session]...Because I was...having fun...I enjoyed reading a tiny bit...I'm happy now that I'm here, that I have other reading." These extracts suggest that child I disliked reading, possibly because of the challenge it posed for him. Yet, in one of the sessions he enjoyed reading because he was having fun. It may be that he was beginning to have a more positive attitude towards reading because of the VRG.

5.3.3. Discussion

5.3.3.1. Theme 1: Enjoyment.

Participants from each grade expressed positive attitudes towards the VRG intervention. The VRG activities and theme appealed to the grade three to six children. This indicates that the format and presentation of the VRG is appropriate for the target age group. The learners' enjoyment of the VRG intervention suggests that they were actively engaged in therapy and were motivated to participate. Only two studies which had qualitative inquiries into learners' attitudes and experiences of ICT-based

reading intervention were found. Both reported that the learners had enjoyed the ICT-based reading programmes and were motivated to use them, similarly to the findings of the present study (Lindeblad et al. 2016; Özbek & Girli, 2017).

Reading enjoyment is associated with reading performance. Results from the 2016 PIRLS showed that there was a positive relationship between learners' reports about how engaged they were during reading lessons and their reading performance (Mullis et al., 2017). Very engaged learners had higher reading achievements than learners who were somewhat engaged and less than engaged learners had the lowest reading achievement (Mullis et al., 2017). Similarly, results from the 2009 Programme for International Student Assessment (PISA) demonstrated a strong relationship between reading enjoyment and reading proficiency (OECD, 2010). Finally, a synthesis of studies conducted in the United Kingdom by the National Literacy Trust found that learners who enjoy reading very much are four times as likely to read above the expected level for their age compared with learners who do not enjoy reading at all and learners who do not enjoy reading at all are ten times as likely to be reading below the expected level for their age compared with children who enjoy reading very much (Clark, 2014). Clearly, reading enjoyment is an important factor associated with reading skill. Therefore, one of the strengths of the VRG is that it is enjoyable to children with reading difficulties.

5.3.3.2. Theme 2: Value of reading partners.

The participants believed that the SLT reading partners played an important role in the intervention. The children enjoyed the social interaction as well as the therapists' support, feedback, and the fun atmosphere they created. Thus, another strength of the VRG may be that an experienced adult reader is involved in its delivery. Adult instruction or mediation may be important to promote children's learning while they are working on computers because adults can adapt their feedback and teaching according to the children's needs (Segal-Drori et al., 2010). There appears to be a paucity of research studies which compare the effect of an ICT programme for different conditions (e.g., child independent versus child supported by adult). One study to examine this factor found that 5 to 6-year-old children who read an electronic book with adult instruction showed greater improvement in phonological awareness and word reading than children who read independently (Segal-Drori et al., 2010). However, the ICT reading intervention studies analysed in chapter two represent programmes which made use of trained adult reading facilitators and those where learners were independent. There are examples of studies with and without adults present which found positive results. Therefore, the impact of an adult reading partner on intervention outcomes is unclear. It may be worthwhile for future studies to explore the relationship of reading partners to ICT programmes' success.

5.3.3.3. Theme 3: Literacy skill and self-competency gains.

The participants believed that their literacy skills improved due to the VRG intervention. In most cases the study findings supported their perceptions of improvement, although given the similar performance to their peers in the control group, the reason may not have been because of the VRG. However, it is possible that the learners made functional reading and spelling gains not detected by the assessments. Nevertheless, the learners expressed increased feelings of literacy self-competence (perceptions of their reading and writing abilities) and confidence as a result of intervention. These affect-related changes may be important.

ICT-based reading intervention studies have found similar results to the current qualitative inquiry. A study showed that learners and parents of the children involved in the study believed that they had made reading skill improvements due to ICT-based reading intervention (Özbek & Girli, 2017). Another study showed that learners felt that they read better after taking part in the project and parents and teachers observed gains in learners' self-confidence as a result of ICT-based reading intervention (Lindeblad et al., 2016).

Studies have found positive relationships between reading self-competency and reading performance (Katzir, Lesaux, & Kim, 2009; Logan & Johnston, 2009). A longitudinal study in Germany found reciprocal effects between reading self-concept and reading achievement in grade five to nine learners (Retelsdorf, Köller, & Möller, 2014). The authors concluded that reading performance influenced learners' beliefs about their abilities and, in grade five and six, learners' reading self-concept influenced their reading achievement (Retelsdorf et al., 2014). Consequently, the participants in the current study's self-competency gains may have resulted in subtle improvements in their literacy skills and may promote reading gains.

Results from PIRLS 2016 showed that there was a large, significant difference in reading achievement between learners who reported a high degree of reading confidence and those who were not confident (Mullis et al., 2017). The very confident learners had higher achievement than the somewhat confident learners and the somewhat confident learners had higher achievement than the learners who were not confident (Mullis et al., 2017). In this vein, the increased feelings of reading confidence which the participants in the current study experienced may have had a small but positive impact on their reading performance.

5.3.3.4. Theme 4: Power to change.

The thematic analysis results indicate that the VRG programme can promote shifts in attitudes towards reading. This is significant, as changing learners' attitudes towards reading is likely one step in the direction of positively influencing their reading abilities. The participants also expressed the

feeling that the programme had the power to improve the reading skills of other learners with reading difficulties. The learners believed that they had benefited from the programme and other children would benefit as well.

Studies have found a positive relationship between reading achievement and reading attitudes (McGeown et al., 2015; Mullis et al., 2017; Petscher, 2010; Schiefele et al., 2012). For example, the PIRLS 2016 results showed that learners who liked reading very much had higher reading performance than those who only somewhat liked reading and learners who somewhat liked reading had higher reading achievement than learners who did not like reading (Mullis et al., 2017). Additionally, a synthesis of research conducted in the United Kingdom found that children who have more positive attitudes towards reading are more likely to read at or above the level expected for their age compared with those who hold more negative attitudes (Clark, 2014). Evidence exists for a bidirectional relationship between reading performance and attitudes toward reading (Mullis et al., 2017). The finding that some of the participants in the current study had a change in attitude toward reading is valuable, as this may foster reading gains. A study by Lindeblad et al. (2016) found that many participants had a change in reading attitudes which influenced their behaviour, as they started reading on their own for pleasure as a result of the ICT-based reading programme. This finding and the results of the VRG qualitative inquiry suggest that ICT-based reading intervention hold promise for causing positive attitude and subsequent reading behaviour and skill shifts.

5.3.4. Thematic Analysis Conclusion

The thematic analysis showed that learners' attitudes towards the VRG and their intervention experiences were largely positive. The learners expressed enjoyment of the VRG and intervention experiences, valued the role of the reading partners, believed they had made literacy skill gains, described self-competency improvements related to their literacy skills, expressed the belief that the VRG could result in reading improvements, and portrayed positive attitudinal and behavioural changes related to reading.

5.4. Chapter Conclusion

The results of the prospective study have been presented and discussed. The quantitative results showed that both the intervention and control groups made improvements over the course of the study. However, the gains of the intervention group were not significantly different to those of the controls on most outcome measures. The VRG intervention may have caused some degree of improvement in learners' reading accuracy and comprehension skills but no evidence suggested that the VRG improved receptive vocabulary skills. The impact of the VRG on reading rate was mixed. The trends in participant dyads showed that, in general, intervention learners did not show a clear advantage over their matched controls. The discussion considered the factors of learners' diagnoses

and weaknesses of the VRG as possible causes of the insignificant results. The themes of the thematic analysis were: (1) enjoyment of the VRG and intervention experiences, (2) value of the reading partners, (3) skill and self-competency gains in literacy, and (4) the programme's power to change attitudes and skills. Each theme was explained and discussed with reference to relevant literature. Chapter six discusses the findings of the retrospective analysis and prospective study and makes recommendations for future research.

Chapter Six

Discussion

6.1. Introduction to Chapter

This chapter presents a summary of the main findings of the study. It then considers the difference between statistical and clinical significance and its relevance to the study results. Next, the findings are compared to ICT-based reading intervention research. The importance of null results is discussed and suggestions for modifications to the VRG to increase its potential effectiveness are made. The findings of the study are then compared to theory and a conceptual framework for population-based reading instruction and intervention for primary school South African children is proposed. Subsequently, the challenges, limitations, contributions and implications of the study are discussed. Lastly, recommendations for future research are made.

6.2. Summary of Findings

The purpose of the retrospective analysis was to determine the effectiveness of peer delivered VRG intervention for grade three to six learners with reading difficulties from mainstream schools. All participants made progress over the course of the study which was likely due to regular language- and reading-based classroom instruction and typical developmental progression. There was no statistically significant difference between the intervention and control groups' reading accuracy, reading rate, receptive vocabulary or reading comprehension at the completion of the VRG intervention. However, the reading accuracy measure of self-corrections was approximating statistical significance (the intervention group made fewer self-corrections and the control group made more from pre- to post-test), suggesting the potential for change in this area. Dyad trend analysis showed that intervention participants did not show improvement advantages compared to their matched controls.

The purpose of the quantitative undertaking of the prospective study was to investigate the effectiveness of SLT-delivered VRG intervention for grade three to six learners with reading difficulties from a school for LSEN. The results showed that all participants' reading skills progressed over the study period and this was likely due to classroom instruction and typical developmental gains. There were no statistically significant differences between the reading accuracy, reading comprehension and receptive vocabulary gains of learners in the intervention and control groups. There was a small statistically significant difference between the gains of the intervention and control groups on one reading rate measure (the control learners read faster and the intervention learners more slowly from pre- to post-test). This finding may indicate that the VRG promoted learners to read more carefully in order to engage with the content which decreased their rate. Furthermore, the gain scores on one measure of reading comprehension were approximating significance (the intervention learners

had higher score gains than the controls) and the performance on the VRG therapy level internal measure of reading errors was approximating significance (the intervention learners read words more accurately than the controls at post-test). These findings indicate that the VRG intervention may have resulted in improvements in reading comprehension and word reading accuracy. Analysis of matched participant pair trends indicated that greater improvement did not occur more frequently for the intervention participants than the control participants.

The qualitative portion of the prospective study aimed to describe learners' attitudes towards the VRG and their intervention experiences. Thematic analysis showed that attitudes towards the VRG and intervention experiences were mainly positive. The learners enjoyed the VRG, were fond of and appreciated having SLT reading partners present and involved in the programme, believed their literacy skills had improved as a result of participation, expressed literacy self-competency improvements, thought the VRG could cause reading skill gains, their reading attitudes became more positive and their reading behaviour changed.

There is no definitive evidence from this study that the VRG programme is effective for improving the reading skills of grade three to six learners with reading difficulties. Nevertheless, there is some support for the conclusion that the programme resulted in a degree of improvement in reading accuracy and reading comprehension and that the VRG intervention had an impact on reading rate as well. Additionally, the VRG appeared to have a positive impact on learners' reading attitudes.

6.3. Statistical Versus Clinical Significance

The distinction between statistical and clinical significance is important when considering the value of interventions. A statistically significant result is one where the p-value of a test statistic is less than a certain threshold (typically set at five percent), indicating that it is unlikely that the results were produced by chance variation between the groups (Bothe & Richardson, 2011; Jakobsen, Gluud, Winkel, Lange & Wetterslev, 2014; Thompson, 2002; van Rijn, Bech, Bouyer, & van den Brand, 2017). The p-value shows the probability of finding an equal or more extreme result by chance when there is in fact no intervention effect (when the null hypothesis is true). Tests of statistical significance do not provide information related to the magnitude of the difference between the groups or the importance of the results (Bothe & Richardson, 2011; Thompson, 2002; van Rijn et al., 2017). Measures of effect size demonstrate the magnitude of the difference between the groups and clinical significance relates to the meaning which researchers, clinicians or participants attribute to the study results. Results are clinically significant if they result in differences which have an impact on individuals' functioning in everyday contexts which is valued and judged to be important (Bothe & Richardson, 2011; Thompson, 2002).

The qualitative results of the study are clinically significant from two standpoints. Firstly, the intervention learners valued the help of the VRG therapy. They noticed improvements in their reading, spelling and written language skills which they attributed to the VRG intervention. Secondly, the learners' affect-related changes are important because they may contribute to future improvements in their reading abilities. The importance of these changes will be described below.

Reading engagement and intrinsic motivation, the interest in and enjoyment of reading because of finding it rewarding and satisfying, has been shown to be strongly related to reading performance (Clark, 2014; Ho & Lau, 2018; Miyamoto, Pfof, & Artelt, 2018; Mullis et al., 2017; OECD, 2010; Soemer & Schiefele, 2018). Children with an interest in reading put more effort into reading and spend more time reading than children who lack interest, which tends to improve their reading abilities (Ho & Lau, 2018; Logan & Medford, 2011; Miyamoto et al., 2018; Schiefele, Stutz, & Schaffner, 2016; Soemer & Schiefele, 2018). The intervention learners' enjoyment of the VRG may have motivated them to complete the reading tasks, facilitated engagement in the reading activities and fostered a receptiveness to learning and opportunities for skill development. The learners' positive reading experiences within the VRG may have encouraged them to seek out other reading experiences. Their enjoyment of the VRG may not have had a major short-term impact on their reading performance, but it may set the stage for future reading progress.

The intervention children believed that the VRG improved their reading skills and they expressed literacy self-competency gains. Children's reading ability influences how much they choose to read; children with strong reading skills read more frequently for pleasure and those who have weak reading skills avoid reading and read less (Logan & Medford, 2011; Soemer & Schiefele, 2018; van Bergen et al., 2018). Moreover, there is a strong positive relationship between reading self-competency and reading performance (Katzir et al., 2009; Logan & Johnston, 2009; Mullis et al., 2017; Retelsdorf et al., 2014). Intervention learners' improvements and beliefs about their improved reading competence may have increased their willingness to persevere when reading (e.g., attempt to decode difficult words) and their desire to read despite its challenges. Such changes could result in future reading gains.

Some intervention participants reported a shift towards having more positive attitudes towards reading and others reported increases in the amount of reading which they engaged in outside of school. These findings are important, as the learners with more positive attitudes may read more frequently which could promote the development of stronger reading skills and those already engaged in more reading may develop a greater interest in the activity, fostering continued reading in the future which could be associated with reading skill gains. Literature supports such propositions, as studies have found strong positive relationships between reading attitudes and reading achievement (Clark, 2014; McGeown et al., 2015; Mullis et al., 2017; Petscher, 2010; Schiefele et al., 2012).

These results suggest that the VRG could be an appropriate programme to use with children who lack reading motivation, have reduced reading confidence, view themselves as having weak reading competence, have negative attitudes towards reading, and do not read frequently. The VRG may promote positive changes to these areas and set children on a path towards a love of reading and reading skill development.

6.4. Comparison of Qualitative Findings with Literature

There is a scarcity of qualitative ICT-based reading studies. When conducting a literature search, only two such studies were found (Lindeblad et al., 2016; Özbek & Girli, 2017). Both studies' qualitative findings were similar to the prospective study's results. Like the current study, these studies showed that learners' attitudes towards using technology and the ICT programmes were positive. They enjoyed using the technology and experienced participation as fun. Their motivation to read and their reading behaviours increased. They experienced self-confidence gains and believed their reading skills improved as a result of their intervention experiences. These findings are encouraging and supportive of ICT use for children with reading difficulties.

Despite the positive qualitative findings of the current study, the quantitative results did not demonstrate significant improvements in learners' reading skills. This outcome can be compared to that of a large randomized control trial conducted in French schools, which evaluated the effect of an intensive programme which aimed to increase low performing grade one learners' reading enjoyment directly and thereby indirectly increase their reading skills (Goux, Gurgand, & Maurin, 2017). The study found that the learners' reading enjoyment increased significantly but this did not translate into improved reading skills in the current or following academic year (Goux et al., 2017). Thus, improvements in affect-related aspects of reading are not necessarily associated with concurrent reading skill gains. It is therefore recommended that programmes aim to target both skill and affect-related aspects of reading rather than targeting either component in isolation.

6.5. Comparison of Quantitative Findings with ICT-based Reading Intervention Studies

The study results have been compared to the ICT-based reading intervention studies included in chapter two (Appendix A1). In contrast to the main findings of the retrospective analysis and prospective study, most ICT-based reading intervention studies describe statistically significant positive intervention effects on the outcomes of (1) word reading accuracy (Ecalte et al., 2009; Ecalte et al., 2013; Fälth et al., 2013; Gustafson et al., 2011; Kyle et al., 2013; Lindeblad et al., 2016; Macaruso & Rodman, 2009; Madden & Slavin, 2017; Messer & Nash, 2018; Mize et al., 2019; Musti-Rao et al., 2015; Saine et al., 2011; Solheim et al., 2018; Torgesen et al., 2010; Yaw et al., 2011); (2) fluency (Barber et al., 2018; Bennett et al., 2017; Madden & Slavin., 2017; Mills-Tetty et al., 2009; Mize et al., 2019; Saine et al., 2011; Savage et al., 2009; Torgesen et al., 2010; van de Ven et al.,

2017; Walcott et al., 2014; Özbek & Girli, 2017); (3) vocabulary (Kim et al., 2011; Lysenko & Abrami, 2014; Potocki et al., 2013); and (4) reading comprehension (Abrami et al., 2016; Barber et al., 2018; Bennett et al., 2017; Ecalle et al., 2013; Fälth et al., 2013; Gustafson et al., 2011; Kim et al., 2011; Lindeblad et al., 2016; Lysenko & Abrami, 2014; Madden & Slavin., 2017; Potocki et al., 2013; Savage et al., 2009; Torgesen et al., 2010). However, similarly to the current study, a number of studies report intervention effects for some but not all of their outcome measures. For example, some studies have not found improvements in learners' (1) word reading accuracy (Abrami et al., 2016; Given et al., 2008; Kim et al., 2010; Kim et al., 2011; Larabee et al., 2014; Macaruso & Rodman, 2009; Savage et al., 2009; van de Ven et al., 2017); (2) fluency (Kim et al., 2010; Kim et al., 2011; Macaruso & Rodman, 2009; Musti-Rao et al., 2015); (3) vocabulary (Abrami et al., 2016; Kim et al., 2010; Macaruso & Rodman, 2009); and (4) reading comprehension (El Zein et al., 2016; Kim et al., 2010; Macaruso & Rodman, 2009) although the programmes targeted and aimed to improve these skills.

The ICT-based reading intervention studies from the literature review (Appendix A1) were analysed to look for factors which appeared to be related to intervention effectiveness. This was done to find possible explanations for the largely insignificant findings of the current study. Studies were categorised as “effective” when positive, statistically significant intervention effects were found for all outcome measures. Studies were categorised as “ineffective” when statistically insignificant effects were found for one or more of the reported outcome measures. These binary criteria were used to clearly distinguish between studies which consistently found clear improvements related to ICT-based reading intervention and those which did not. The results of this undertaking will be reported below and considered in relation to the current study.

Most of the studies (91.66 percent) conducted in Europe were effective. In contrast, 58.82 percent of the studies conducted in North America were effective and none of the studies conducted in Africa were effective. It is not clear why this pattern was found. It is possible that it is related to the type of ICT programmes analysed, methodological factors or population characteristics. For example, the two studies conducted in Africa and the current study used outcome measures which were not developed for or normed on the study population. It may be that outcome measures specifically developed for the local context would have yielded different results. However, the discrepancy of the effectiveness of studies conducted in different parts of the world is not necessarily meaningful as it is an extremely broad factor, and the outcomes measures chosen for the current study were the best available ones at the time of the project.

Trends were sought for the factor of study sample size and design but no clear patterns emerged. There was a fairly even distribution of studies with small, medium and large sample sizes finding positive intervention effects (the percentage differences between different sample size groups was

marginal). Moreover, there were minor percentage effectiveness differences between studies which employed different designs. Intervention outcome did not appear to be related to study design for this review. Meta-analyses of ICT-based reading intervention studies have found that, in general, studies with smaller sample sizes have much higher effect sizes than those with larger sample sizes (Cheung & Slavin, 2011; Cheung & Slavin, 2013; Moran et al., 2008). It has been suggested that this is due to small-scale studies being able to maintain higher implementation fidelity than large-scale studies, small-scale studies using informal outcome measures more frequently than large-scale studies, and small-scale studies with null results not being written up or published whereas large-scale studies funded by the government or other organisations or institutions are more likely to be written and published regardless of the findings (Cheung & Slavin, 2011; Cheung & Slavin, 2013; Moran et al., 2008). With regards to study design, meta-analyses have shown that studies with quasi-experimental designs produced much larger effect sizes than true experimental designs (Cheung & Slavin, 2011; Cheung & Slavin, 2013). This finding may be related to the higher degrees of internal and external validity associated with experimental designs (Tredoux & Smith, 2006). These results suggest that the findings of the current study would not necessarily have been more positive (and may even have been less positive) had a larger sample size or experimental design been used.

Studies conducted with children in the lower primary school grades (one to three) were more often effective than those conducted in the higher primary school grades (four to seven). Of those with lower primary school participants, 66.66 percent were effective whereas only 37.5 percent of studies which used higher primary school learners were effective. Older learners with reading difficulties may not respond as well to reading intervention as younger learners due to factors such as brain plasticity and unhelpful reading patterns being more established (Banich & Compton, 2011). Similarly to the finding of the current review, studies have found that learners in the younger primary school grades show greater improvements related to traditional and ICT-based reading interventions than learners in the higher primary school grades (Cheung & Slavin, 2013; Flynn et al., 2012; Kim et al., 2010; National Reading Panel, 2000; Torgesen et al., 2007; Wanzek et al., 2013; Wise et al., 2000). Therefore, the current study may not have found clear intervention-related reading improvements due to the target grade being reflective of an age where reading difficulties are difficult to address.

The factor of participant selection criteria was examined. The studies which used participants at risk of reading difficulties and with reading difficulties were largely effective (80 percent and 73.68 percent respectively). In contrast, none of the studies which used participants from mainstream schools who did not have specified reading challenges were effective. Other ICT-based reading intervention studies have found comparable results; learners with lower pre-intervention reading ability have made greater gains than learners with higher pre-intervention reading skills (Cheung & Slavin, 2011; Fogarty et al., 2017; Wise et al., 2000). This finding may be related to mainstream learners having reading skills which are already adequate or strong and therefore do not show large

gains after intervention. Alternatively, the ICT-based programmes may be designed to improve challenges which typical readers do not experience and therefore the intervention is not beneficial for them. The retrospective analysis of the current study used mainstream learners who were identified as having reading difficulties but whose scores on reading assessments showed skills largely within the average range for their ages. The findings of this analysis support the idea that statistically significant intervention effects were not found for the retrospective analysis due, at least in part, to the factor of participants' pre-test reading skill characteristics. The prospective study made use of learners with reading difficulties from a school for LSEN and the results were more positive (there were more measures approximating statistical significance and one measure which reached statistical significance). Reading skill profiles of children thus seems to be a factor associated with ICT-based reading intervention success.

The level of reading skill targeted by the ICT-based interventions was analysed. Interventions which focused on word-level skills (including phonological awareness, phonics, word reading and pseudoword reading) had the highest rate of intervention effectiveness (77.77 percent). Interventions which focused on passage-level skills (reading fluency and reading comprehension) had a lower intervention effectiveness representation (60 percent). It is possible that word-level interventions are more effective than passage-level interventions because they require fewer skills. Passage-level reading requires the integration and coordination of a greater number of reading skills and cognitive systems (Wolf, Ullman-Shade, & Gottwald, 2012). Finally, only 40 percent of the studies which used interventions which focused on both word- and passage-level skills were effective. This finding may be related to the amount of intervention time available to target each component skill (i.e., interventions targeting a few skills are able to intensively target and consolidate skills whereas interventions targeting a number of skills may train each skill less deeply because intervention time has to be divided among many target areas). No ICT-based reading intervention studies (which examined the factor of reading level targeted) were found to compare to the findings of this review. The findings of this review therefore suggest that one of the limitations of the VRG may be that it targets both word-level and passage-level skills.

The number of components targeted by the ICT-based interventions was then scrutinised. The following skills were each considered separate components for this undertaking: phoneme-grapheme knowledge/ phonics, phonological awareness, word reading/ pseudoword reading/ sight word reading, reading fluency, sentence/ passage reading, reading comprehension, vocabulary, listening comprehension, spelling/ writing, receptive language skills (other than vocabulary) and expressive language skills (other than vocabulary). Interventions which targeted one to two components were the most effective (80 percent). Interventions which targeted three to five components were less effective (69.23) percent. Lastly, only 12.5 percent of the interventions which targeted six to eight components were effective. The studies which used interventions that targeted fewer skills may have displayed an

advantage because each skill could be addressed in sufficient depth. These findings suggest that there is a negative relationship between the number of intervention targets and the success of the intervention. No ICT-based reading intervention studies (which analysed the factor of number of components targeted) were found to compare to the results of this review. The VRG targets five skills (phonics, word reading, reading fluency, vocabulary and reading comprehension). It is possible that the results of the current study would have been more positive if fewer skills had been targeted in intervention.

The technological device used to deliver the intervention was considered and showed that 60.86 percent of the interventions provided via computers were effective and 50 percent of the interventions given via iPads/ tablets were effective. The one study which used an iPod and the one study which used both smartphones and tablets were not effective. It is not clear whether the difference observed in the effectiveness of studies using different devices is meaningful or important. If it is meaningful, factors such as children's familiarity with using and operating devices and the size of the font and text could be potentially relevant. The researcher looked for studies that explored the impact of technological device on ICT programme success, but none were found and thus only the results of the current review can be interpreted. Computers and iPads were used to deliver the VRG intervention in the current study. The results may have been more positive if only computers had been used but this would require further research to demonstrate.

The potentially important factor of intervention intensity could not be analysed for this review. The methods used to report on intervention intensity lacked consistency. For example, many studies neither reported on the total number of intervention sessions nor the total intervention time. Other studies examining the impact of intervention intensity in traditional and ICT-based reading programmes have found disparate results; some show greater gains for higher intensities, some show greater improvements associated with lower intensities and others report equivalent gains regardless of intervention intensity variables (Cheung & Slavin, 2011; Cheung & Slavin, 2013; Denton et al., 2011; Dunn, 2015; Galuschka et al., 2014; McGinty et al., 2011; National Reading Panel, 2000; Ross & Bengeny, 2015; Storkel et al., 2017; Ukrainetz et al., 2009; Wanzek & Vaughn, 2008; Wanzek et al., 2013). At this point it is unknown whether manipulating intervention intensity variables would result in greater improvements being associated with VRG programme use.

The influence of intervention designer on ICT programmes' outcomes could not be determined for this review because many studies did not report on who was involved in forming the interventions (e.g., researchers, clinicians or commercial organisations). A meta-analysis of ICT-based literacy programmes for grade six to eight learners found that interventions created by a research team had larger effect sizes than commercially created products (Moran et al., 2008). This finding may be related to researcher-designed programmes having aims and activities based on theoretical constructs,

research literature and clinical experience which make them more effective than programmes which lack such underpinnings. The VRG was designed by an SLT with knowledge related to literacy theory and research as well as experience in providing literacy-based interventions to learners. Nevertheless, the VRG programme's efficacy could likely be improved through deeper consideration and application of reading research information into its approach and activities. Specific suggestions related to modifications which may need to be made to the VRG are discussed later in the chapter (~6.8.).

Involvement of individuals in the delivery of the ICT-based intervention and the identity of the individuals may be important for intervention success. Studies which had trained special education/remedial teachers involved in intervention provision were the most effective, as all of the studies which used them were effective. The next most effective group was of the studies where researchers provided the intervention to the learners; 80 percent of these studies were effective. Most studies (66.66 percent) which had interventions which learners accessed and used independently were effective. None of the studies which used trained teachers were effective and very few (25 percent) of the studies which used other trained adults (e.g. tutors and research assistants) were effective. These findings tentatively suggest that ICT interventions which involve the presence/ support of an adult who is an expert in the field of reading intervention (e.g. special education teachers/ researchers) can be more effective than interventions where learners are independent and interventions delivered by adults without specialist knowledge of reading therapy. Reading partners' theoretical knowledge and practical experience related to reading instruction and intervention may contribute to the success of ICT programmes. Meta-analyses have found that researcher-delivered reading intervention tends to produce much larger intervention effects than those delivered by teachers and learners (Galuschka et al., 2014; Scammacca et al., 2015; Suggate, 2016). For the retrospective analysis of the current study, learners (peers) provided support to the participants during VRG intervention. Experienced SLTs facilitated intervention in the prospective study. One of the SLTs had experience providing literacy-related intervention (on a daily basis for the last three and a half years) whereas the other mostly had experience providing language- and speech-related intervention. The outcome of the VRG intervention may have been more positive if only researchers or SLTs/ learning support teachers with extensive literacy-related expertise and experience had been used for both studies.

The last factor which was investigated was outcome measures. There was a trend towards studies which used informal/ non-standardised outcome measures having a higher rate of effectiveness (66.66 percent of the studies) compared to those which used standardised/ norm-referenced outcome measures (of which 55 percent were effective) and those which used both informal and standardised measures (of which 50 percent were effective). A meta-analysis of ICT-based reading intervention found that studies with informal outcome measures and those designed by researchers specifically for evaluating programmes' outcomes showed stronger intervention effects than those with standardised

outcome measures (Moran et al., 2008). It is possible that this finding is related to the informal/ researcher-developed non-standardised assessments being more related to classroom-based skills and therefore more clinically valid, being more sensitive to subtle improvements in skills, showing higher rates of measurement error and lower rates of reliability across time or informal/ researcher-developed measures “teaching to the tests” which makes results less generalisable (Moran et al., 2008). For the current study, none of the results from the standardised outcome measures reached statistical significance or approximated statistical significance. In contrast, the results from some of the informal/ non-standardised outcome measures approximated statistical significance and reached statistical significance. Although these assessments may have been more sensitive to treatment effects, they may also have been less valid and reliable measures of reading improvement. Future studies should consider such factors when deciding whether to use standardised, informal or a combination of outcome measures.

In conclusion, methodological trends within ICT-based reading intervention studies were evaluated in an attempt to find factors which may be related to programme effectiveness. The results were compared to the current study and possible explanations for the generally insignificant findings were made. It should be noted that a fairly small number of studies (31) were analysed for this discussion. The studies may have contained methodological shortcomings and publication bias may have been implicated (~2.3.2.). Descriptive statistical methods rather than parametric, inferential statistics have been used. Therefore, results should be interpreted as tentative possibilities rather than hard and fast evidence.

6.6. Importance of Null Results

It is important to note that null findings, such as those of the retrospective analysis and prospective study, are valuable to science. Publication bias occurs when publication is related to the significance of the results (the tendency for statistically significant results to be published more frequently than insignificant ones) (Djulgovic & Guyatt, 2017). Consequences of publication bias include hindering accurate knowledge accumulation, misrepresentation of the effectiveness of interventions, inflating the mean effect sizes of interventions in meta-analyses, false claims becoming canonised as facts, and information becoming unfalsifiable due to replication studies with null results not entering the evidence base (Ferguson & Heene, 2012; Franco et al., 2014; Gage et al., 2017; Guan & Vandekerckhove, 2016; Nissen et al., 2016; Nosek et al., 2012; Song et al., 2013). Publication bias can be mitigated through the writing up and dissemination of null results (Ferguson & Heene, 2012; Franco et al., 2014; Gage et al., 2017; Guan & Vandekerckhove, 2016; Nissen et al., 2016; Nosek et al., 2012; Song et al., 2013).

6.7. Explanations for the Null Results

Some possible explanations for the null results were discussed in detail in chapters four and five (~4.3.3. and 5.2.2.3.) and have been explored in this chapter as well (~6.5.). Explanations related to the null findings of the retrospective analysis include learners' skills being too high at study onset and peer reading partners being used. Accounts of the null findings of the prospective study are related to participants' diagnoses and reading partners having insufficient reading intervention experience and expertise. Potential explanations relevant to both studies include insufficient training of reading partners, participants' age and grade (being older and in higher primary school grades) and limitations of the VRG (intervention not being specific to learners' core reading deficits, no phonological awareness targets, no systematic/ synthetic phonics approach, too few exemplar words for each phonic pattern, not all fluency-enhancing techniques incorporated, no vocabulary-learning strategy instruction, potentially insufficient language targets to result in reading comprehension improvements, no reading comprehension strategy instruction, targeting both word-level and passage-level skills, and targeting too many reading skills).

6.8. Suggestions for Modifications to the VRG

It is recommended that the developers of the VRG aim to align all aspects of the programme to reading theory and evidence-based research in a clearly defined and systematic manner. Such steps would likely contribute significantly to increasing the programme's likelihood of resulting in meaningful and measurable reading skill gains. The results of the current study tentatively indicate that the following changes to the VRG could potentially increase the programme's effectiveness: (1) providing steps to ensure children's core reading deficits are focused on and that therapy is individualised and specific to children's unique reading challenges, (2) introducing activities which aim to improve phonological awareness skills, (3) ensuring a systematic, synthetic phonics approach is used, (4) increasing the number of exemplar words to be practiced for each phonic pattern, (5) enabling reading partners to model fluent reading of the passages before children read them, (6) creating opportunities for passages to be read at least three to four times for reading fluency targets, (7) providing opportunities for vocabulary-learning strategies to be explicitly taught and applied, (8) increasing the emphasis of language-based tasks to foster reading comprehension, (9) providing opportunities for reading comprehension strategies to be explicitly taught and applied, (10) re-designing the programme so that it focuses only on word-level or passage-level reading skills, (11) re-designing the programme so that it focuses on fewer reading skills, and (12) including comprehensive reading partner training of the explicit instruction, practice opportunities, scaffolding, support and feedback procedures to be used with children during the programme. One or more of these changes may need to be made to the VRG to increase its likelihood of causing positive reading skill developments.

6.9. Relating Findings to Theory

Theories which classified children into groups according to their reading strengths and weaknesses were the most relevant to the study. Two frameworks were particularly useful: the simple view of reading (Gough & Tunmer, 1986) and the double deficit hypothesis of dyslexia (Wolf & Bowers, 1999). These frameworks could be applied to the current study because participants had recognised reading impairments.

As demonstrated in chapter five, all participants in the prospective study could be classified into one of Gough and Tunmer's simple view of reading quadrants: (1) good decoding and good comprehension, (2) good decoding and poor comprehension, (3) poor decoding and good comprehension, and (4) poor decoding and poor comprehension. The model enables VRG targets to be selected for learners based on their classification. Learners with good decoding and poor comprehension would require language-related intervention (e.g., the VRG vocabulary and reading comprehension activities). Children with poor decoding and good comprehension would require decoding-related intervention (e.g., the VRG phonics and word-reading activities). Children with poor decoding and poor comprehension would require the language- and decoding-related VRG intervention. However, the model's ability to be applied to the current research study is limited in two areas. Firstly, the model does not consider that children with good decoding and good comprehension may have reading difficulties which require treatment. The prospective study had one such participant, who had good decoding and comprehension skills according to the model and yet he had still been identified by his teacher as having a reading difficulty. This was because he had a reading fluency (speed) deficit, something which the model does not consider. Secondly, the model does not explain the different deficits that can result in a decoding difficulty.

Wolf and Bowers (1999) proposed the double-deficit hypothesis to explain developmental dyslexia. As shown in chapter five, all prospective study participants could be subtyped as having: (1) phonological deficits (poor phonological awareness and decoding with or without reading comprehension difficulties and no naming speed difficulties), (2) naming speed deficits (poor RAN/RAS resulting in fluency and/ or reading comprehension difficulties but no phonological difficulties) and (3) double-deficits (phonological and naming speed deficits). This framework was helpful, as it provided an explanation for learners' reading fluency difficulties and for understanding that not all learners had the same basis to their decoding difficulties. Just like learners' VRG targets could be developed from their classification based on the simple view of reading components, learners' VRG targets could also be selected based on the double-deficit hypothesis subtypes. For example, learners with phonological deficits would complete the phonics-based activities of the VRG, learners with naming speed deficits would complete the fluency-based activities of the VRG and those with phonological and naming speed deficits would complete phonics and fluency activities. Regardless of

subtype, the learners who had co-occurring reading comprehension difficulties would complete the vocabulary and comprehension activities of the VRG.

The simple view of reading and double-deficit hypothesis could be used to develop protocols to support South African school children's reading skills. The models demonstrate the importance of oral language, phonological, naming speed, decoding and reading comprehension skills in reading. Thus, the models suggest that all learners require quality instruction and opportunities to practice and develop phonological awareness and phonics skills, oral language skills, reading fluency skills and reading comprehension skills. Learners identified as at risk for reading difficulties based on the results of screening assessments (e.g., of oral language, naming speed and phonological skills) would need to receive timely intervention to strengthen their skills. Learners identified as having reading difficulties based on assessments (e.g., on decoding and reading comprehension tasks) would need to receive individualised intervention based on their unique pattern of reading skill strengths and weaknesses. Further ideas related to how reading-related research and the findings of the current study could inform practice in South Africa are discussed in following section of this chapter (~6.10.).

6.10. A Conceptual Framework for Population-based Reading Instruction and Intervention for South African Primary School Children

The South African Department of Basic Education, in consultation with other relevant government departments, requires urgent action and strategy to improve the reading performance of school children. The community-based rehabilitation programme guidelines, although originally formed to promote the inclusion and participation of disabled people in society, could be used as a framework for the action (World Health Organisation [WHO], 2010). The stages of the programme would be as follows: (1) situation analysis – the problems related to learner reading achievement which need to be addressed would be identified; (2) planning and design – a plan to address the problems would be made; (3) implementation and monitoring – the programme would be executed and carefully monitored; and (4) evaluation – the outcomes of the programme would be measured and it would be determined whether the programme achieved its aims (WHO, 2010). The results of the evaluation stage could be used to make adaptations and modifications to improve the programme and further clarify the key areas which need to be addressed (WHO, 2010). In this way, the stages would occur in a cycle (Figure 3) and the programme could move ever closer towards achieving the ultimate aim of all learners achieving the intended reading outcomes of each grade (WHO, 2010).

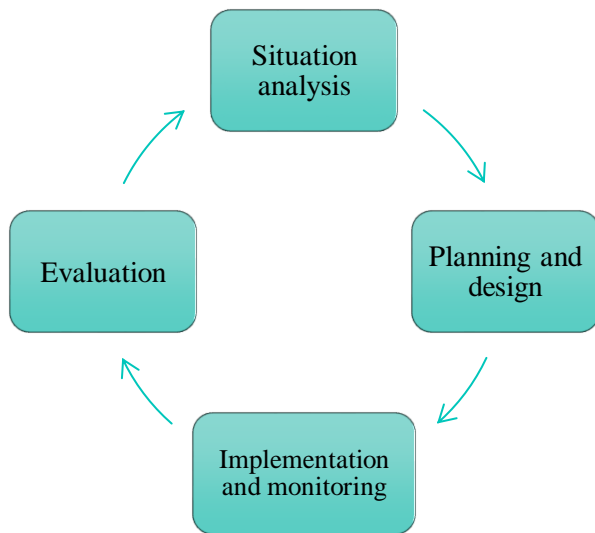


Figure 3: Stages of community-based rehabilitation

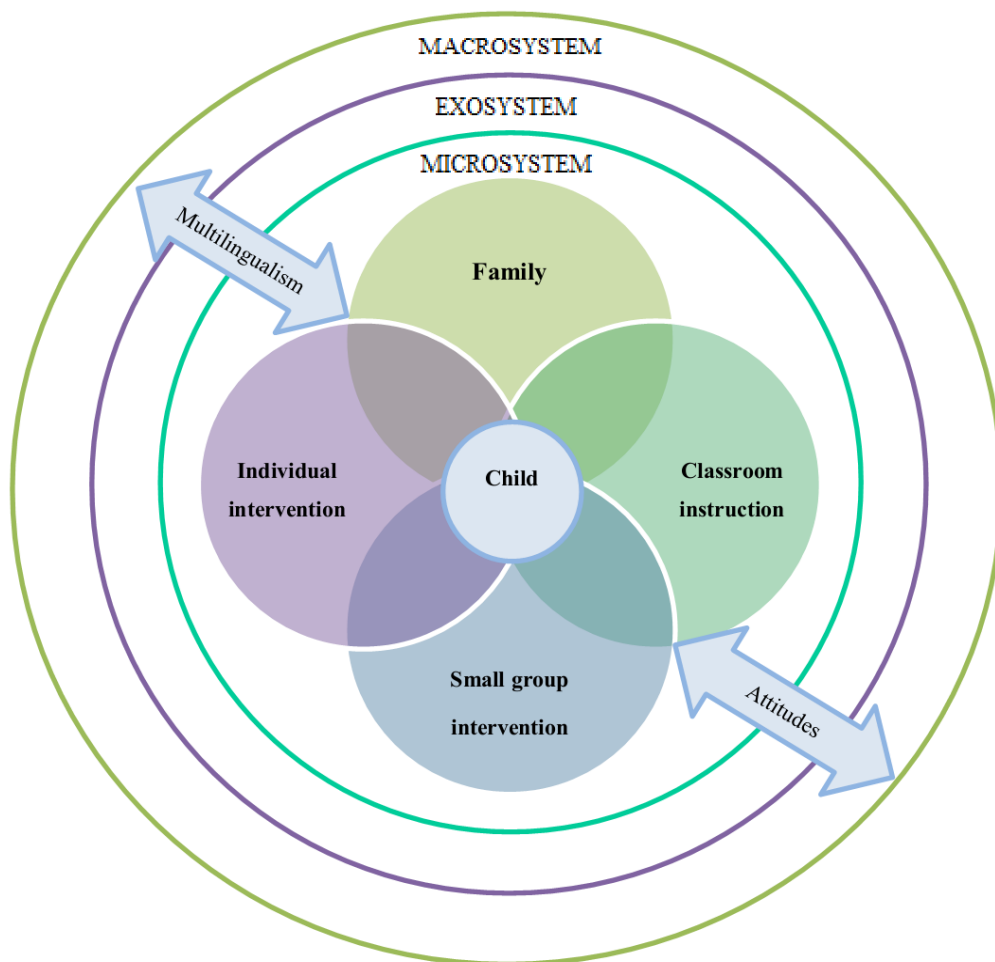


Figure 4: Population-based reading instruction and intervention for South African primary school children

A tentative conceptual framework (Figure 4) for population-based reading instruction and intervention for South African primary school children is proposed in this section of the chapter. The framework serves to guide reading instruction and intervention services and to highlight areas from which individual programmes (targeting separate components of the framework) could be designed, implemented and evaluated in South African contexts. Two theoretical models have been used to develop the framework, the bioecological model of human development (Bronfenbrenner, 1979, 1989, 1995, 2005; Bronfenbrenner & Morris, 1998, 2006) and the response to intervention (RTI) educational framework.

The bioecological model of human development proposes that individuals are influenced by the interactions among systems in their context (Bronfenbrenner & Morris, 2006). Although literacy was not a domain originally considered by the framework, recent research has emphasised the bioecological model's usefulness in the field (Axelsson, Lundqvist, & Sandberg, 2019; Jaeger, 2016; Rojas-Drummond, 2016). The systems of the bioecological model are: (1) microsystems – elements of the child's immediate environment (e.g., family, peers, classroom); (2) exosystems – external networks (e.g., medical and educational institutions, places of employment, religious institutions, community groups, mass media); (3) macrosystems – the larger social setting (e.g., social conditions, cultural values, economic patterns, political philosophies, legislation and policy); (4) chronosystem – historical time period; and (5) mesosystem – interactions and connections between parts of single systems and between different systems (Bronfenbrenner & Morris, 2006). According to the model, children's development is also influenced by their personal attributes known as demand characteristics (e.g. age, race, sex, behaviour), resource characteristics (e.g. medical and educational diagnoses and disabilities, genetic factors, skills, knowledge, experience) and force characteristics (e.g., temperament and personality as well as cognitive, social, emotional and motivational factors) (Bronfenbrenner & Morris, 2006). The components of the model which are emphasised in the current conceptual framework are the child; microsystems (family, classroom instruction, small group intervention and individual intervention; exosystems (the school system) and macrosystems (legislation, policy, socioeconomic factors and cultural values/ attitudes). The factors of multilingualism and attitudes towards reading impact each system and have thus been included in the framework as well.

RTI is an empirically supported educational framework for preventing reading difficulties by careful assessment, frequent progress monitoring and the provision of evidence-based reading instruction and intervention through tiers which offer increasingly intense levels of support (Ardoin et al., 2005; Burns, Scholin, Kosciolk, & Livingston, 2010; Carta et al., 2015; Catts et al., 2015; Coyne et al., 2018; Denton, 2012; Field, Begeny, & Kyung Kim, 2019; Fuchs & Fuchs, 2006; Greenfield et al., 2010; Greenwood et al., 2011; Hughes & Dexter, 2011; Justice, 2006; Keller-Margulis, 2012; Rose, 2006; Sanger et al., 2012a; Sanger et al., 2012b; Spear-Swerling, 2013; Speece et al., 2011). Tier one

consists of classroom instruction, tier two includes small group intervention in addition to classroom instruction and tier three involves individual intervention as a supplement to classroom instruction (Ardoin et al., 2005; Burns et al., 2010; Carta et al., 2015; Catts et al., 2015; Coyne et al., 2018; Denton, 2012; Field et al., 2019; Fuchs & Fuchs, 2006; Greenfield et al., 2010; Greenwood et al., 2011; Hughes & Dexter, 2011; Justice, 2006; Keller-Margulis, 2012; Rose, 2006; Sanger et al., 2012a; ; Sanger et al., 2012b; Speece et al., 2011). The same three tiers are proposed for the current conceptual framework. An RTI approach is proposed so that emphasis is placed on all learners being provided with quality reading instruction and opportunities to develop strong reading skills and as a means of prioritising reading intervention services in the resource-constrained context.

6.10.1. Child.

South African children's unique characteristics should be considered when making decisions related to reading instruction and intervention. Demand characteristics which are particularly relevant include age (e.g. younger children respond better to reading intervention) and sex (boys' reading skills are generally weaker than girls' and there is a higher prevalence of reading difficulties in boys than girls) (Cheung & Slavin, 2013; Flynn et al., 2012; Kim et al., 2010; Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017; National Reading Panel, 2000; OECD, 2004; OECD, 2010; OECD, 2013; OECD, 2016; Spaul, 2013b; Torgesen et al., 2007; Wanzek et al., 2013; Wise et al., 2000). Resource characteristics which should be taken into account include risk factors (e.g. family history of dyslexia due to its known genetic origin), medical/ health conditions (e.g. learners who attend school tired and hungry have poorer reading performance than learners who are not sleep deprived and have adequate nutrition, higher prevalence of reading difficulties among learners with certain diseases, disabilities and disorders), reading experience (e.g. learners who are frequently absent from school have fewer opportunities to develop appropriate reading skills, learners who attend preschool have higher reading performance than children who do not), and reading skills (e.g. learners' responsiveness to intervention is related to their current level of reading abilities) (Asbell et al., 2010; Brown et al., 2013; Compton et al., 2012; Harris et al., 2017; Mullis et al., 2012; Mullis et al., 2017; Ozernov-Palchik, Yu, Wang, & Gaab, 2016). Force characteristics such as children's attitude towards reading and their interests are relevant to service delivery as well (Clark, 2014; Ho & Lau, 2018; Katzir et al., 2009; Logan & Medford, 2011; McGeown et al., 2015; Miyamoto et al., 2018; Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017; OECD, 2004; OECD, 2010; OECD, 2013; OECD, 2016; Petscher, 2010; Retelsdorf et al., 2014; Schiefele et al., 2012; Schiefele et al., 2016; Soemer & Schiefele, 2018; van Bergen et al., 2018).

6.10.2. Microsystem.

6.10.2.1. Family.

The home environment and parents' behaviours play a critical role in children's reading achievement. In order for the reading skills of South African learners to improve, parents need to receive education and training related to how they can support their children's reading development and the knowledge they gain needs to be applied to daily routines and interactions. It is important that parents provide ample opportunity for children to develop strong oral language skills because such skills contribute to reading success (Griffin, Hemphill, Camp, & Wolf, 2004; Paradis et al., 2011; Reese, Sparks, & Leyva, 2010a; Reese, Suggate, Long, & Schaughency, 2010b). Parents should engage in early literacy activities with their children (e.g. singing songs, telling stories, reading books, playing with alphabet toys, playing word games) as there is a positive relationship between reading achievement and parents engaging their children in early literacy activities before starting school (Howie et al., 2017; Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017; Reese et al., 2010a). Funding related to providing underprivileged families with literacy resources should be considered, as there is a positive association between reading attainment and having resources that support learning at home (Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017). Additionally, parents should be encouraged and trained how to play an active role in their children's education (e.g. collaborate with the teacher and be involved in homework tasks) as this has been shown to foster reading skill development (Howie et al., 2017; Modisaotsile, 2012; Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017). Evidence-based ICT reading programmes could be used by children at home in families who have access to electricity, internet and technological devices. However, considering the socio-economic barriers faced in the country, the use of ICT-based programmes in most South African households is not feasible and would likely be limited to the minority of children from financially advantaged homes (Spaull, 2015).

6.10.2.2. Tier one: Classroom instruction.

The following procedures should be followed within tier one: provision of evidence-based classroom reading instruction to all learners, universal screening at the beginning of the academic year to identify learners at risk of reading difficulties, re-assessment of learners identified as at risk after a specified period and if results indicate inadequate response (skills lower than those of peers and below average performance on norm-referenced or criterion-referenced measures) then tier two support should be provided, and the progress of all learners should be monitored through frequent curriculum-based assessments so that class-based instruction can be modified to meet learners' needs (Ardoin et al., 2005; Burns et al., 2010; Carta et al., 2015; Catts et al., 2015; Coyne et al., 2018; Denton, 2012; Field et al., 2019; Fuchs & Fuchs, 2006; Greenfield et al., 2010; Greenwood et al., 2011; Hughes & Dexter, 2011; Justice, 2006; Keller-Margulis, 2012; Rose, 2006; Sanger et al., 2012a; Sanger et al.,

2012b; Speece et al., 2011). Skills such as letter knowledge, phonological awareness, rapid naming, nonword reading and vocabulary could be tested to screen learners' risk for reading difficulties (Catts et al., 2017; Catts et al., 2015; Fostick & Revah, 2018; Borleffs et al., 2018; Lervåg, Bråten, & Hulme, 2009; Ozernov-Palchik et al., 2016; Pennington et al., 2012; Pennington, 2006; Speece et al., 2011; Torgesen, 2000; Wolf, 2008).

Because of the shortage of reading intervention professionals working in the South African education sector, those with specialist knowledge related to language and literacy should primarily focus on ensuring quality classroom-level services are provided (Kathard & Moonsamy, 2015; Moonsamy, 2015). For example, SLTs should collaborate with teachers and be involved planning and co-teaching classroom literacy skills (Justice, 2006; Kathard & Moonsamy, 2015; Moonsamy, 2015). It is important that core components of reading such as phonological awareness, phonics, fluency, vocabulary and reading comprehension are targeted in classroom instruction. Instruction within each component should be explicit and systematic, organised sequentially, follow consistent instructional routines and clearly link instruction across all the components (Hughes & Dexter, 2011; McDonagh, 2017; National Reading Panel, 2000; Rose, 2006). The Curriculum Assessment and Policy Statement guidelines as well as other evidence-based programmes could be used to inform classroom practices. ICT-based programmes could be effectively employed here if the infrastructure is available in schools and optimal interventions are developed and tested. However, affordability of such programmes may prevent widespread adoption from being possible.

Due to the lack of assessments designed for and normed on South African children, screening and assessment measures will either need to include tests standardised on other populations or informal/classroom-based/ criterion-referenced measures which schools have at their disposal (Caesar & Kohler, 2007; Pascoe & Norman, 2011; Roberts, 2008; Saenz & Huer, 2003). It is important that tools with sufficient validity and reliability are selected so as to minimise false positives (learners identified as being at risk of reading difficulties although they are not) and false negatives (learners who are actually at risk being identified as not being at risk) (Hughes & Dexter, 2011; Speece et al., 2011). There is a need for South African assessment tools to be created so as to aid in the appropriate identification of reading delays and disorders and the management of such diagnoses (Caesar & Kohler, 2007; Pascoe & Norman, 2011; Roberts, 2008).

6.10.2.3. Tier two: Small group intervention.

Tier two intervention should include the provision of research-validated small group reading intervention to those identified as at risk (as a supplement to regular classroom instruction), frequent progress monitoring, the returning to tier one of learners who have responded adequately to a specified period of intervention time, and learners who have not made sufficient reading skill gains entering tier three (Ardoin et al., 2005; Burns et al., 2010; Carta et al., 2015; Catts et al., 2015; Coyne

et al., 2018; Denton, 2012; Field et al., 2019; Fuchs & Fuchs, 2006; Greenfield et al., 2010; Greenwood et al., 2011; Hughes & Dexter, 2011; Justice, 2006; Keller-Margulis, 2012; Rose, 2006; Sanger et al., 2012a; ; Sanger et al., 2012b; Speece et al., 2011). The same aims as targeted in the classroom should be covered in tier two with the differences being greater intensity and the use of a smaller group of learners with more similar learning needs (Justice, 2006). ICT-based reading interventions could be used in tier two if there is sufficient evidence of their efficacy and resources are available.

6.10.2.4. Tier three: Individual intervention.

Tier three should involve comprehensive assessment of learners' academic and reading skills to inform intensive one-on-one reading intervention support services (provided as a supplement to regular classroom instruction), progress monitoring to determine whether/which learners are ready to return to lower tiers, learners who do not respond/ make sufficient gains would be considered to have likely reading disorders or disabilities (neurobiological deficits preventing response to instruction and intervention which has been beneficial to the majority of learners), and learners with identified reading disorders would either continue to receive intensive individual reading intervention at mainstream schools or be referred to and placed in special education for continuation of high levels of reading intervention support (Ardoin et al., 2005; Burns et al., 2010; Carta et al., 2015; Catts et al., 2015; Coyne et al., 2018; Denton, 2012; Field et al., 2019; Fuchs & Fuchs, 2006; Greenfield et al., 2010; Greenwood et al., 2011; Hughes & Dexter, 2011; Justice, 2006; Keller-Margulis, 2012; Rose, 2006; Sanger et al., 2012a; Sanger et al., 2012b; Speece et al., 2011).

The results of the current study suggest that it would likely be important for professionals with knowledge related to reading and reading intervention experience to be responsible for delivering the intervention, the intervention should be based on reading theory and research, there should be ample evidence of the intervention's efficacy, intervention should be sufficiently intense, intervention should be individualised and target learners' unique reading skill deficits, and the intervention would need to be financially and practically sustainable. Furthermore, research suggests the reading intervention should target important literacy aims, key skills and strategies should be taught, instruction should be explicit, there should be plenty of opportunities for independent and guided reading practice, and corrective and positive feedback should be provided (Denton, 2012; McDonagh, 2017; National Reading Panel, 2000). If ICT-based reading interventions fulfil these criteria, they could be used in tier three – cost and infrastructure permitting.

6.10.3. Exosystem.

6.10.3.1. School.

It is important for school system factors to change so that the reading performance of South African learners can improve. Literature suggests that schools with high morale, high academic expectations and emphasis on academic success, high levels of parental support, sufficient resources, high levels of home-school involvement, highly qualified and educated teachers, teachers with experience, satisfied teachers, high levels of teacher support, low levels of teacher absenteeism, sufficient time spent on teaching, quality reading instruction, sufficient opportunities to engage in reading tasks, following and completing the curriculum, giving homework to learners, high levels of safety and well-managed discipline have learners with stronger reading skills and achievement than those from schools who do not have these characteristics (Graven; 2014; Hoadley, 2012; Howie et al., 2017; Justice, 2006; Kathard et al., 2011; Modisaotsile, 2012; Mullis et al., 2003; Mullis et al., 2007; Mullis et al., 2012; Mullis et al., 2017; Nadler-Nir & Pascoe, 2016; Taylor & von Fintel, 2016; van Staden & Bosker, 2014; Wium et al., 2010). As a matter of priority, the education department and school governing bodies should aim to address the areas which require attention at schools and have programmes to systematically improve the school conditions.

6.10.4. Macrosystem

In relation to macrosystem components, it is important that legislation, policy and funding to support the implementation of all areas within the conceptual framework are in place. Special attention should be paid to improving health and socio-economic conditions, as addressing these areas will likely have a beneficial impact on the state of education and reading achievement in the country.

6.10.5. Factors relevant to all systems.

6.10.5.1. Multilingualism.

Seeing as South Africa is a multilingual society, a number of language-related factors should be considered when applying elements of the proposed framework. Firstly, parents should be educated and trained how to use the home language as well as the language of learning and teaching to support language and literacy development (Paradis et al., 2011). Secondly, teachers and clinicians should receive education and training related to core principles and approaches to use when working in multilingual classroom and intervention contexts (Kritikos, 2003; Paradis et al., 2011). Thirdly, there is a need for teachers, SLTs and reading support/remedial teachers to be given opportunities to become proficient in the learners' home language and to be qualified and adequately trained to offer reading instruction and intervention services in the language of learning and teaching/ learners' home language (Kritikos, 2003; McLeod, Verdon, Bowen, & International Expert Panel on Multilingual

Children's Speech, 2013; Roberts, 2008). This could be accomplished through universities and colleges including courses and modules on multilingualism as part of their degree/ training programmes, professional development courses, and the recruitment of African language speakers into the teaching, SLT and reading support professions (Barratt et al., 2012; De Lamo White & Jin, 2011; McLeod et al., 2013; Roberts, 2008).

The home language should be used as the medium of instruction at school for as many years as possible before the transition to English is made, as this has been shown to lead to the best academic and literacy outcomes (Hakuta et al., 2000; Heugh, 2005; Taylor & von Fintel, 2016). Efforts should be made to uphold the additive bilingualism approach endorsed by the Language in Education Policy by implementing its key principles (Kathard et al., 2011; Lear, 2018). Thus, English should be taught as a subject from the beginning of primary school and learners should have sufficient proficiency (be able to engage at an academic level with the language) before the transition is made to English as the language of learning and teaching (Alvear, 2019; Heugh, 2005; Jordaan, 2011; Kathard et al., 2011; Shepherd, 2018). Moreover, once the transition to English is made, the home language should continue as a school subject (Paradis et al., 2011; Shepherd, 2018). Furthermore, the home language should be used to scaffold and support the development of English language and literacy skills (August & Shanahan, 2006; Paradis et al., 2011). If English ICT-based reading programmes are used in tiers one to three, it would be important for learners' home languages to be used to support English language and reading skill acquisition. Methods for using existing programmes in such a way would need to be developed or new programmes which have explicit activities upholding an additive bilingualism approach would need to be created. Possibilities related to how the VRG could be used within South Africa's multilingual context are considered in section 6.12.

Long-term goals to be considered for the South African education system include (a) education in learners' home languages for the duration of their school career and (b) dual-language education where both the home language and English are used as the mediums of instruction (to promote the development of proficient language and literacy skills in both languages) (Bialystok 2018; Christian, 2016; Dicks & Genesee, 2016; Shepherd, 2018). There is currently a lack of educational resources in African languages and thus efforts should be made towards developing such resources so that long-term goals such as these can be realised.

6.10.5.2. Attitudes to reading.

Attitudes (feelings, emotions, thoughts and beliefs) related to reading have an important influence on all of the systems in the suggested framework. Research has shown that there is a positive relationship between learners' reading attitudes such as motivation, engagement, enjoyment, fondness of reading, confidence, and self-competence and their reading achievement. It is therefore important that, at the level of the microsystem, parents, teachers, SLTs and other professionals involved in learners' reading

development foster positive attitudes towards reading in the home, classroom and intervention contexts (e.g., through demonstrating reading behaviours themselves, providing time and opportunities for learners to read, engaging in interesting and enjoyable reading activities with the children, providing learners with choice and autonomy related to reading decisions, and providing opportunities to speak about and discuss what has been read) (Mitchell, 2018; Rose, 2006). Within the exosystem, schools should ensure their curriculum places an emphasis on promoting positive reading attitudes and staff should receive training related to the importance of promoting positive reading attitudes and be given practical advice for how to do so. At the macrosystem level, policy should contain theoretical and research-based information related to reading attitudes and offer guidelines for implementation in home, community and educational settings. The results of the present study show that it would be valuable for future research to explore the use of ICT-based reading interventions to promote positive attitudes to reading.

6.10.6. Summary of framework.

The conceptual framework for population-based reading instruction and intervention for primary school children aims to offer a preliminary guide for improving the reading skills of South African children. The bioecological model of human development was used to demonstrate the importance of addressing contextual factors when targeting the reading crisis. The RTI model was included so as to provide a means of ensuring all learners have the opportunity to develop reading competence and of prioritising higher levels of reading support for learners with the greatest need. Individual elements of the framework could be targeted by separate programmes which could be implemented and evaluated with a community-based rehabilitation model.

6.11. Challenges and Limitations

There were some challenges involved in the prospective study. First, once the data collection phase could be entered into, the school term dates imposed a restriction on the length of the intervention period. Thus, the number of weeks of intervention was limited by this factor. Second, intervention dosage was decreased for participants due to school activities (e.g., learners were not permitted to leave class for intervention sessions on days when they had to write tests or attend school outings). Third, intervention dosage was reduced for some participants because of their absenteeism from school. Finally, there were problems with the wireless internet connection at times, which meant the VRG could not be accessed. This issue indicates that the VRG could not be feasibly used in the future in settings without stable internet connections which has implications for the type of schools where the VRG could be implemented (e.g., it may not be suitable for disadvantaged schools which lack wireless internet access).

Limitations for both the retrospective and prospective study included that a non-random sample was used (specific schools in Cape Town were approached and participants were volunteers), the sample size for each study was small (n=20), and a matched-subject design was used (participants were matched on a restricted number of factors and random assignment took place at the unit of each pair rather than the unit of the whole group). These limitations affected the generalisability of the results to the wider population and the power of the statistical tests. The intervention and control groups were not equivalent in the number of participants they had with various personal characteristics. The participants were matched according to pre-test assessment performance. However, better equivalence may have been guaranteed had the learners been matched according to other characteristics as well such as age, grade, gender, primary diagnosis and additional intervention services being received. Nonetheless, the small sample size prevented participants from being matched on all relevant characteristics.

Researcher involvement in pre- and post-test assessments and the learner interviews is an additional limitation of the prospective study. Financial constraints prevented external researchers from conducting all the data collection. Steps were taken to ensure the reliability and validity of the thematic analysis results (e.g., review of the interview schedule, piloting of the interview schedule, a sample of the audio recorded interviews and transcriptions being checked by the supervisor). Moreover, it is a limitation that the research assistants who were responsible for providing the VRG intervention were involved in conducting the pre- and post-intervention assessments. However, measures were taken to promote the validity and reliability of the results (e.g., the researcher re-scored a sample of the pre- and post-assessments, research assistants only conducted post-test assessments for learners other than those they had provided VRG therapy to).

Blinding was not implemented for the study. The researcher and research assistants were aware which learners belonged to the intervention and control groups. Class teachers, parents and learners themselves were aware of learners' group membership as well. This may have introduced bias into the study results. Yet, the insignificance of the quantitative results suggests that knowledge of intervention status did not lead to advantages in the intervention group. On the other hand, the learners' positive expressions in the interviews with the researcher may be related to the Hawthorne effect and participant bias (e.g., the learners providing the responses which they believed the researcher desired and expected). The researcher attempted to mitigate these effects by explaining to the learners that "there were no right or wrong answers" and that their responses would be kept anonymous and private (not shared with their reading partners). Further limitations of the qualitative study were that only post-test interviews were conducted (thus changes in learners' attitudes could not be described) and only intervention participants were interviewed (meaning comparisons between the intervention and control groups could not be made). However, these limitations existed because of the

research aim, which was to evaluate learners' attitudes to the VRG and their intervention experiences. Thus, knowledge of the programme and involvement in intervention was necessary.

There were assessment-related limitations of the study as well. There were no measures of phonological awareness although it is widely recognised as a core deficit in many children with reading difficulties (Frijters et al., 2011; Hulme & Snowling, 2014; Katzir et al., 2008; Lovett et al., 2000; Manis et al., 2000; O'Brien et al., 2012; Rose, 2009; Song et al., 2016; Wolf & Bowers, 1999; Wolf & Bowers, 2000; Wolf et al., 2002; Wolf, 1999; Wolf, 2010). The battery did not have phonological awareness assessments because the VRG does not target these skills and phonological awareness is sometimes viewed as important for younger children in the earlier phases of literacy development. However, the literature suggests that phonological awareness can be implicated in the reading weaknesses of older struggling readers and thus the battery should have contained such a measure (Duff & Clarke, 2011; Duff & Clarke, 2011; Gillon & McNeill, 2009; Gillon, 2017; Goldsworthy, 2003; National Reading Panel, 2000; Schuele & Boudreau, 2008; Snowling & Hulme, 2011). Additionally, the assessment battery had no standardised assessments which contained South African norms and thus the assessments were not necessarily valid and reliable measures of the South African children's skills. Nevertheless, to the researcher's knowledge, there are no reading assessments which have been normed on the South African population. To mitigate this limitation, raw scores rather than standardised scores were used when conducting statistical tests. Additionally, the elapsed time between reassessment was very brief and introduced the possibility that both intervention and control learners' gains in scores from pre- to post-test were related to practice effects. This limitation existed due to time and budget constraints. Finally, due to time constraints, no pre-test in-built VRG assessments (at the level of therapy) were conducted. It is thus unknown whether the groups were well-matched (equivalent) at this level at pre-test and this reduces the dependability of the results from this assessment.

The study had limitations related to confounding variables. First, some participants continued to receive remedial and language therapy during the intervention period. This occurred due to a request from the school and the ethical implications which may have been associated with not allowing learners to receive their usual academic support for the sake of the study. This limitation makes it difficult to determine the cause of learners' skill gains (e.g., whether related to the VRG, remedial, language therapy or natural maturation). Second, minimal information was collected about the school support participants received (e.g., the content and dosage), which would have made it difficult to tease out whether the VRG or the school support was implicated in improvements (had the study results been more positive). Third, intervention participants left class for intervention at different times and during different school subjects three times per week based on their individual timetables. Control children continued with their usual classes and activities during the times when intervention learners received the VRG intervention. Therefore, there was a lack of equivalence between the

groups and variability within the intervention group related to what classroom instruction they missed to attend VRG sessions. Confounding would have been better controlled for had all intervention learners received the VRG during a set class activity (e.g. independent reading time) or non-academic time (e.g. before or after school). School, learner and reading partner schedule factors prevented this from occurring during the study.

6.12. Contributions

The study contributed by extending previous enquiry related to the VRG and responding to the call for additional research to be conducted. Through the completion of the retrospective analysis, the current study extended the 2017 VRG study and followed recommendations for research to use a small sample of the original data to complete a fine-grained analysis so that VRG efficacy could be better understood (Pascoe et al., in preparation). The prospective study offered a unique contribution because no previous studies had investigated the effectiveness of SLT-delivered VRG intervention, used participants from a school for LSEN or had a qualitative inquiry which evaluated participants' attitudes towards the VRG.

The study was valuable because it investigated a practical solution to address South African learners' reading difficulties by examining a locally designed ICT-based reading intervention (the VRG). The study found little evidence that the VRG resulted in reading skill improvements. However, the study contributed by proposing a tentative conceptual framework for population-based service delivery in South Africa based on the study findings and a review of relevant research literature. Additionally, suggestions related to changes which could be made to the VRG to increase its potential effectiveness were provided. Developers of the VRG could use the recommendations to make modifications to the programme and its delivery. Researchers could investigate whether these changes result in more successful learner outcomes. Such steps could initiate the process of the VRG becoming an evidence-based tool for use in the local context, and its implementation as part of the conceptual framework outlined in this chapter.

The findings of the thematic analysis showed that learners had positive attitudes towards the VRG and their intervention experiences. This is an important contribution of the study as it establishes the VRG as a tool which could potentially be used to shift learners' attitudes towards reading. Improvements in reading attitudes could lead to reading competence gains.

The current study was important because if the results had found that the VRG resulted in reading skill improvements for mainstream and LSEN learners with reading difficulties, it could have been proposed as a tool to be used within an RTI framework in South African schools. For example, it could be used as a component of the core curriculum reading instruction in tier one, a supplement to classroom instruction in tier two and for learners with reading disorders in tier three. The findings of

the current study show that there is currently insufficient evidence of the VRG's effectiveness to recommend its application within an RTI approach. It is also worth considering that, seeing as the VRG is a commercial programme, funding would be required to purchase accounts for learners as well as to train staff in its delivery and thus cost, time and practical constraints may be factors preventing the VRG's implementation in public and underprivileged schools.

The VRG's online platform makes it accessible at all settings which have internet and technology, making it have the potential to be used intensively to develop reading skills and reach a large number of children in need of reading intervention (Nadler-Nir & Pascoe, 2016). It would therefore appear that establishing the effectiveness of the VRG would be useful for determining whether such a tool could be used in South African contexts. However, schools and families in rural and disadvantaged communities may be particularly unlikely to have the resources to make use of ICT programmes possible (such as electricity, internet and technological devices), teachers may require comprehensive and ongoing training to support learners using the programme, and parents' own literacy proficiency may prevent them from being able to assist their children. These factors raise the concern that the VRG may not be a suitable programme for the largest proportion of the population and the schools and children which have the greatest need of reading support.

The VRG's texts were written by a South African author for South African children. Nevertheless, it should be noted that the VRG passages are not necessarily linguistically or culturally relevant for children from a variety of cultural and socioeconomic backgrounds (Pascoe & Norman, 2011; Pascoe et al., 2013). For example, passages in the first level of the VRG include expository texts about animals (e.g. tigers, electric eels, blue crane birds, spiders); home projects (e.g. how to make bird seed mixture for garden birds, how to grow an avocado tree, how to dye celery with food colouring); and descriptions of children completing various activities (e.g. painting a picture, getting a new pet, starting primary school, winning an award). On a surface level, it appears that these topics do not reflect the knowledge or experiences of children from a diverse range of backgrounds. Moreover, the vocabulary used in texts may be unfamiliar to many South African children (e.g. one of the passages states that the ingredients for the home project should be bought at "the supermarket" although the term "shop" may be the more commonly used term in the country). Therefore, adaptation of the VRG texts may be necessary to make it a more contextually suitable tool.

The VRG could be translated for use in multilingual contexts. At present, there is insufficient evidence to warrant the translation or adaptation of the VRG for use with other South African languages. If a substantial research base develops to suggest that the VRG results in English reading skill improvements, resources could then be directed towards enabling its use with non-English speaking children. There are a number of scenarios through which multilingualism could be incorporated into the VRG. Different language versions of the VRG could be created (e.g., the VRG

could be translated into isiXhosa so that the interface, instructions, sounds, words and passages were in isiXhosa), the VRG could be used as a starting point to create a similar programme for another South African language (e.g. rather than the VRG being translated, certain elements of the VRG could be maintained but new activities and passages could be developed based on isiXhosa language and literacy properties), a bilingual version of the programme could be developed (e.g., an English-isiXhosa programme could be created that contains English and isiXhosa versions of each activity such as an English text appearing alongside an isiXhosa version of the same passage or a dictionary function which allows word translations and meanings to be viewed in both languages), or bilingual reading partners could receive comprehensive training related to how to use the VRG to support the English language and literacy skills of learners with African home languages (e.g., how to translate the English sounds and words into isiXhosa for the learners, how to use isiXhosa as a scaffold to support English skill development). These possibilities could be considered if future research of VRG effectiveness is more promising.

The VRG has the potential to be used with a broad range of trained reading partners such as learners, siblings, parents and community volunteers; thereby taking into account the professional resource shortages in South Africa and enabling a more population-centred approach to intervention provision (Acker & Klop, 2015; Kathard & Moonsamy, 2015; Kathard et al., 2011; Moonsamy, 2015; Nadler-Nir & Pascoe, 2016; Wium & Louw, 2013). However, the findings and analysis of the current study suggest that reading interventions may have a higher likelihood of positive treatment effects when individuals with knowledge of literacy development and intervention provide the therapy. Thus, at this point it is recommended that efforts are directed towards determining whether the VRG can result in positive reading gains when delivered by trained reading intervention professionals. If such undertakings prove successful, the outcomes of using non-professional reading partners could be explored further.

6.13. Recommendations

It is recommended that future research investigates whether the VRG promotes improvements in children's reading skills. Strong study designs (e.g. randomised control trials which make use of blinding for conducting assessments) and large sample sizes (which have adequate statistical power) should be used. Variables such as whether participants receive additional language and reading support and the lessons which VRG sessions replaces for intervention participants should be controlled for.

Research should explore factors related to participant characteristics (e.g., typically developing readers, learners at risk for reading difficulties, mainstream learners with reading difficulties, children with learning disabilities and reading difficulties, second language learners) to evaluate whether the VRG is beneficial for different groups of children. It is suggested that future research uses trained

professionals (e.g. SLTs, educational psychologists, teachers, learning support teachers or remedial teachers) as the VRG reading partners and if efficacy is demonstrated then future work could explore whether non-professionals (e.g. parents, siblings, adult volunteers, peer volunteers) could be used successfully as well.

It is suggested that research is conducted with younger primary school learners, such as children in grade two, to determine whether the VRG is effective for children of this age and grade group. There is evidence to suggest that children respond better to reading intervention when in the early primary school years (Cheung & Slavin, 2013; Flynn et al., 2012; Kim et al., 2010; National Reading Panel, 2000; Spaul, 2013b; Torgesen et al., 2007; Wanzek et al., 2013; Wise et al., 2000). It is important for learners' reading difficulties to be addressed during the sensitive periods of development to prevent difficulties from continuing to persist (Cheung & Slavin, 2013; Flynn et al., 2012; Kim et al., 2010; National Reading Panel, 2000; Spaul, 2013b; Torgesen et al., 2007; Wanzek et al., 2013; Wise et al., 2000).

Evidence suggests that intervention provided in the early primary school years is more cost-effective than intervention provided at a later stage (Spaul, 2013b). Nonetheless, research should continue to investigate the effectiveness of the VRG for older primary school learners as well, because many children continue to struggle with reading past the early school years (Cheung & Slavin, 2013; Nadler-Nir & Pascoe, 2016).

It is recommended that future research investigates the linguistic and cultural appropriateness of the VRG content for different groups of South African learners. This would help to determine contexts in which its use is suitable. Research which offers practical suggestions and strategies of how to make the content accessible to children from various socioeconomic and cultural groups would be beneficial as well.

Research investigating the use of the VRG for English second language learners (e.g. learners who attend a school where English is the language of learning and teaching but have isiXhosa as their home language) holds potential promise. Bilingual English-isiXhosa teachers could be trained to act as the VRG reading partners and provide translation to learners as necessary during VRG intervention sessions. Research could investigate whether such methods improve learners' English language and reading skills. If future research provides evidence that the VRG programme can result in significant reading skill gains, possibilities related to translation and adaptation of the programme for use in other South African languages could be considered as well.

It may be worthwhile for studies to include measures of spelling and written language, as learners expressed the belief that their written language and spelling skills improved due to the VRG intervention. Measures of phonological awareness and phoneme-grapheme knowledge could be

included in assessment batteries as well, due to their association with reading ability (Gillon, 2017; Rose, 2006; Rose, 2009). Furthermore, intervention and control participants should be assessed at the level of VRG intervention which they require (using the inbuilt VRG measures) at pre- and post-test. This would allow improvements to be detected and conclusions related to the VRG's impact to be drawn.

It would be valuable for studies to explore the efficacy of the VRG intervention for various groups of children to discover the impact of the programme for children with different characteristics. The effects of these variables (e.g., age, grade, sex, diagnoses, mainstream school versus school for LSEN, type of reading difficulty, severity of reading difficulty, home language) on the effectiveness of the VRG programme could be investigated. Moreover, research into the behaviour of the reading partner during intervention (e.g., type of feedback, frequency of feedback, use of reinforcements, use of strategies to promote learner meta-cognition and text comprehension) would be useful. The information could be used to develop a structured and efficacious set of guidelines for reading partners to follow and a clearer understanding of what training of reading partners should entail.

The intensity of the VRG should be explored to determine whether modifying dose, dose form, dose frequency, duration, dosage, opportunities for learner responses, amount of corrective feedback and the timing of the corrective feedback result in more positive treatment outcomes. At present, the intensity of VRG intervention required to achieve a treatment effect and the optimal VRG intervention intensity for educationally meaningful improvements in reading skills are unknown. It would be valuable to determine whether an increase in VRG intervention intensity (e.g. intervention over a period of a school semester or school year, greater number of hours of total intervention) is associated with positive reading skill gains.

It would be useful for future research to evaluate the individual components of the VRG separately, to determine if, in isolation, they are effective for improving the skills they were designed to remediate. The effectiveness of the fluency, phonics, vocabulary and reading comprehension components should be explored in greater depth. Moreover, future research should investigate the relative importance of reading partner feedback versus the VRG inbuilt features on learners' reading outcomes. Future studies may need to explore whether the feedback and support offered by reading partners needs to be refined and become more structured in order for learners' skills to develop.

If future research does not find evidence to support the use of the VRG for children with reading difficulties, the developers of the VRG should rethink the scientific and theoretical underpinnings of the programme. In this case, modifications to the VRG should be made based on careful study of reading intervention and ICT literature. The recommendations related to changes made in this chapter (~6.8) could be used as a starting point.

Additional qualitative inquiry into the VRG would be valuable as well. Research could explore reading partners' attitudes towards the VRG and providing VRG intervention. Learner participants could be interviewed before and after VRG intervention to determine whether their attitudes change over time. Affect-related factors such as reading motivation, reading self-confidence and reading enjoyment could be explored in more depth using both quantitative and qualitative measures. Investigations determining the relationship of learners' reading attitudes, motivation, self-confidence and enjoyment to their reading skill gains could be explored as well. It may be beneficial to determine whether the VRG results in changes to learners' reading-related affect and whether such changes have positive consequences for learners' self-esteem, academic performance or reading performance.

It is recommended that a meta-analysis of ICT-based reading interventions is conducted which specifically analyses the factors associated with programmes being successful (result in meaningful skill gains) or unsuccessful (not being associated with significant gains in reading skills). Such a study would be helpful in informing the type of modifications it may be necessary to make to the VRG programme and it could be used to guide the international community of ICT-based reading intervention developers and researchers when new programmes are created.

The reviews of ICT-based reading intervention literature which were conducted for the current study revealed a lack of uniformity in the way intervention details were reported in study research papers. This is problematic as it prevents comparisons among studies to be made and conclusions which could be used to guide future research directions to be drawn. It is suggested that future research papers report on all of the following intervention intensity factors: the total number of sessions, the number of sessions per week, the total intervention time, the duration of the sessions in minutes or hours, and the period of time which intervention was extended over (how many weeks/ months/ years of intervention). It is recommended that future papers report on who developed the reading skill activities and teaching methods offered by the ICT-based programmes as well.

There is a need for multilingual South African speech-language therapy and reading assessments to be developed and normed on the population so that delays and disorders can be appropriately diagnosed and treated (Barratt, Khoza-Shangase & Msimang, 2012; Caesar & Kohler, 2007; International Expert Panel on Multilingual Children's Speech, 2012; Pascoe & Norman, 2011; Roberts, 2008; Southwood & van Dulm, 2015). Researchers should thus invest in the process of creating culturally and linguistically appropriate assessment tools to be used in South Africa.

Researchers, clinicians and educators should collaborate to explore practical solutions to address the literacy crisis in South Africa. Research related to methods of providing all learners with high quality reading, spelling and written language instruction in the classroom and preventing literacy problems would be invaluable. Intervention research exploring cost-effective and evidence-based means of

improving the skills of those who present with barriers to literacy and literacy difficulties would be highly beneficial as well.

6.14. Chapter Conclusion

This chapter presented a summary of the main findings of the study. The retrospective analysis showed that peer-delivered VRG intervention for grade three to six learners with reading difficulties from mainstream schools did not result in statistically significant improvements to learners' reading accuracy, rate, vocabulary or comprehension. The quantitative component of the prospective study found that SLT-delivered VRG intervention for grade three to six learners with reading difficulties from a school for LSEN did not lead to statistically significant gains in reading accuracy, reading comprehension and vocabulary. However, there was a statistically significant difference between the gains of the intervention and control groups on one reading rate measure (the control learners read faster from pre- to post-test while the intervention learners read more slowly). The findings of the qualitative component of the prospective study were that learners had positive attitudes towards the VRG and their intervention experiences. Learners enjoyed the programme, valued the reading partners, believed their literacy skills had improved, expressed self-competency gains, believed that the VRG could improve learners' literacy skills and voiced attitudinal and behavioural changes towards reading.

The chapter then went on to explore the difference between statistical and clinical significance and its relevance to the study results. Next, the findings were compared to ICT-based reading intervention research. The importance of null results was discussed and suggestions for modifications to the VRG to increase its potential effectiveness were made. The findings of the study were then compared to theory and a conceptual framework for population-based reading instruction and intervention for primary school South African children was proposed. The challenges, limitations and contributions of the study were then discussed. Finally, recommendations for future research were made.

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Appendices: Chapter Two

Appendix A1

Table 1: Articles included in the ICT-based reading intervention literature review

Authors	Date	Journal	Country
Mize, Bryant, & Bryant	2019	<i>Assistive Technology</i>	US
Barber et al.	2018	<i>Learning Disabilities: A Contemporary Journal</i>	US
Messer & Nash	2018	<i>Journal of Research in Reading</i>	UK
Solheim, Frijters, Lundetræ, & Upstad	2018	<i>Learning and Instruction</i>	Norway
Bennett, Gardner, Cartledge, Ramnath, & Council	2017	<i>Education and Treatment of Children</i>	US
Madden & Slavin	2017	<i>Reading & Writing Quarterly</i>	US
Özbek & Girli	2017	<i>Universal Journal of Educational Research</i>	Turkey
van de Ven, de Leeuw, van Weerdenburg, & Steenbeek-Planting	2017	<i>Journal of Computer Assisted Learning</i>	The Netherlands
Abrami, Wade, Lysenko, Marsh, & Gioko	2016	<i>Education and Information Technologies</i>	Kenya
El Zein et al.	2016	<i>Journal of Developmental and Physical Disabilities</i>	US
Lindeblad, Nilsson, Gustafson, & Svensson	2016	<i>Disability and Rehabilitation: Assistive Technology</i>	Sweden
Schneider et al.	2016	<i>Reading Psychology</i>	US
Musti-Rao, Lo, & Plati	2015	<i>Remedial and Special Education</i>	US
Larabee, Burns, & McComas	2014	<i>Journal of Behavioral Education</i>	US
Lysenko & Abrami	2014	<i>Computers & Education</i>	Canada
Walcott, Marett, & Hessel	2014	<i>Journal of Applied School Psychology</i>	US
Ecalte, Kleinsz, & Magnan	2013	<i>Computers in Human Behavior</i>	France
Fälth, Gustafson, Tjus, Heimann, & Svensson	2013	<i>Dyslexia</i>	Sweden
Kyle, Kujala, Richardson, Lyytinen, & Goswami	2013	<i>Reading Research Quarterly</i>	UK
Potocki, Ecalte, & Magnan	2013	<i>Computers & Education</i>	France
Gustafson, Fälth, Svensson, Tjus, & Heimann	2011	<i>Journal of Learning Disabilities</i>	Sweden
Kim, Capotosto, Hartry, & Fitzgerald	2011	<i>Educational Evaluation and Policy Analysis</i>	US
Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen	2011	<i>Child Development</i>	Finland
Yaw et al.	2011	<i>Journal of Behavioral Education</i>	US
Kim, Samson, Fitzgerald, & Hartry	2010	<i>Reading and Writing: An Interdisciplinary Journal</i>	US
Torgesen, Wagner, Rashotte, Herron, & Lindamood	2010	<i>Annals of Dyslexia</i>	US
Ecalte, Magnan, & Calmus	2009	<i>Computers & Education</i>	France
Macaruso & Rodman	2009	<i>European Journal of Special Needs Education</i>	US
Mills-Tetty et al.	2009	<i>Information and Communication Technologies and Development</i>	Ghana
Savage, Abrami, Hipps, & Deault	2009	<i>Journal of Educational Psychology</i>	Canada
Given, Wasserman, Chari, Beattie, & Eden	2008	<i>Brain and Language</i>	US

Note. US is an abbreviation for the United States of America. UK is an abbreviation for the United Kingdom. Papers are ordered chronologically by year and alphabetically within years.

Appendix A2

Table 2: Design and participant characteristics of studies included in the ICT-based reading intervention literature review

Study	Design	Participant characteristics				
		n=	Grade	Age (years; months)	Sex	Selection criteria for inclusion
Mize et al. (2019)	Multiple baseline across participants	4	5	10-11	M+F	Diagnosis of a reading learning disability
Barber et al. (2018)	Multiple baseline across participants	3	1	7;3 (M)	M+F	Learning English as a second language, at risk for reading difficulties and special education
Messer & Nash (2018)	Randomised control trial	78	-	7;5 (M)	M+F	School-identified poor progress in reading-related activities
Solheim et al. (2018)	Randomised control trial	744	1	6;2 (M)	M+F	At risk of reading difficulty
Bennett et al. (2017)	Multiple baseline across participants	7	2	7;8 (M)	M+F	Below average on reading fluency test
Madden & Slavin (2017)	Pre- and post-test (random assignment to intervention and control groups)	872 (study 1) 736 (study 2)	1-3	-	-	Lowest 30% for grade reading tests
Özbek & Girli (2017)	Multiple baseline across participants	3	3-4	8-9	M+F	Significantly below grade level reading
van de Ven et al. (2017)	Multiple baseline across participants	69	-	8;8 (M)	M+F	Poor reading skills
Abrami et al. (2016)	Pre- and post-test (random assignment to intervention and control groups)	354	2	-	M+F	Mainstream learners
El Zein et al. (2016)	Alternating treatment	3	4-6	10;4 (M)	M	A diagnosis of autism spectrum disorder (ASD) and below grade level reading skills
Lindeblad et al. (2016)	Pre- and post-test	35	4-6	10-12	M+F	Dyslexia, literacy impairments and reading difficulties
Schneider et al. (2016)	Pre- and post-test (random assignment to intervention and control groups)	170	2	-	-	Public elementary school learners
Musti-Rao et al. (2015)	Multiple baseline across participants	3 (study 1) 3 (study 2)	1	6;3-7;9	M+F	At risk of reading difficulty
Larabee et al. (2014)	Multiple baseline across participants	3	1	6	M+F	Below grade level reading skills
Lysenko & Abrami (2014)	Pre- and post-test	351 (study 1) 166 (study 2)	1-2	-	M+F	Mainstream learners
Walcott et al. (2014)	Multiple baseline across participants	3 (study 1) 3 (study 2)	1 (study 1) 2 (study 2)	6-7 (study 1) 8-9 (study 2)	M+F (study 1) M (study 2)	Teacher-identified reading difficulty and attention problems
Ecalte et al. (2013)	Pre- and post-test (random assignment to intervention and control groups)	27 (study 1) 18 (study 2)	2 (study 1) 1 (study 2)	7;6 M (study 1) 6;6 M (study 2)	M+F	Lowest scores on word reading test from sample (n=110) (study 1) Lowest scores on word reading test from sample (n=101) (study 2)

Fälth et al. (2013)	Pre- and post-test (random assignment to intervention and control groups)	130	2	-	M+F	Teacher-identified reading difficulty
Kyle et al. (2013)	Pre- and post-test	31	2	6	M+F	Teacher-identified reading difficulty
Potocki et al. (2013)	Randomised control trial	30	2	7;6-7;7 (M)	-	Lowest scores on listening comprehension assessment from sample (n=258)
Gustafson et al. (2011)	Pre- and post-test (random assignment to intervention and control groups)	130	2	-	M+F	Reading disability
Kim et al. (2011)	Randomised control trial	312	4-6	10;5 (M)	M+F	Below average on an English language assessment
Saine et al. (2011)	Randomised control trial	166	1	7	M+F	At risk of reading difficulty
Yaw et al. (2011)	Multiple baselines across participant	1	6	12	M	A child with ASD from a school for learners with special educational needs and sight word reading difficulties
Kim et al. (2010)	Randomised control trial	294	4-6	-	M+F	Below average on an English language assessment
Torgesen et al. (2010)	Pre- and post-test (random assignment to intervention and control groups)	112	1	6;6 (M)	M+F	At risk of reading difficulty
Ecalle et al. (2009)	Randomised control trial	28	1	6;10 (M)	M+F	Lowest scores on standardised assessment of word reading from sample (n=90)
Macaruso & Rodman (2009)	Pre- and post-test (random assignment to intervention and control groups)	47	6-7	-	M+F	Lowest scores on standardised reading assessment
Mills-Tetty et al. (2009)	Alternating treatment	89	2-4	-	M+F	Learners from private, public and informal schools
Savage et al. (2009)	Randomised control trial	144	1	6;8 (M)	M+F	Mainstream learners
Given et al. (2008)	Pre- and post-test (random assignment to intervention and control groups)	65	6-8	12;5 (M)	M+F	Teacher-identified reading difficulty

Note. *n* refers to the sample size. (M) refers to the mean. M refers to male. F refers to female. + indicates "and". - indicates that the information could not be found in the article. Papers are ordered chronologically by year and alphabetically within years.

Appendix A3

Table 3: Characteristics of the interventions included in the ICT-based reading intervention literature review papers

Study	Name/ description	Skills targeted in activities	Mode of delivery	Facilitator	Dosage
Mize et al. (2019)	K12 Timed Reading Practice and peer-assisted reading instruction	Reading fluency	iPad	Learners independent	22 sessions 4-5 sessions a week 12 minutes per session
Barber et al. (2018)	Reading RACES (Relevant and Culturally Engaging Stories)	Reading fluency and reading comprehension	Computer	Learners independent	7-11 weeks 1-4 sessions per week 20-30 minutes per session
Messer & Nash (2018)	Trainertext	Phoneme-grapheme knowledge/ phonics, phonological awareness and decoding	Computer	Learners independent	10 months 2-3 sessions per week 10–15 minutes per session
Solheim et al. (2018)	On Track intervention with either additional Norwegian GraphoGame or additional On Track ABC application	Phoneme-grapheme knowledge/ phonics, word reading, text reading, spelling and reading comprehension	Tablet	Learners independent	25 weeks 4 sessions per week 45 minutes per session
Bennett et al. (2017)	Researcher-designed repeated reading software of culturally relevant passages	Reading fluency and comprehension	Computer	Researcher	7-13 weeks 3-5 sessions per week 20-30 minutes per session
Madden & Slavin (2017)	Tutoring with Alphie	Phoneme-grapheme knowledge/ phonics, phonemic awareness, word reading, fluency, vocabulary, and reading comprehension	Computer	Trained tutors	School year 5 sessions per week 30 minutes per session
Özbek & Girli (2017)	Pre-listening, repeated reading, performance feedback and reward techniques	Reading fluency	iPad	Researcher	1 session per week 13-15 sessions 20 minutes per session
van de Ven et al. (2017)	Letter Prince	Phoneme-grapheme knowledge/ phonics, word reading, reading comprehension and fluency	iPod	Adult assistant	9 sessions 15 minutes per session
Abrami et al. (2016)	ABRACADABRA	Phoneme-grapheme knowledge/ phonics, phonemic awareness, word reading, fluency, vocabulary, listening and reading comprehension and writing	Computer	Trained teachers	13 weeks 2 hours per week
El Zein et al. (2016)	Space Voyage	Reading comprehension	iPad	Trained research assistant	16 sessions 35 minutes per session
Lindeblad et al. (2016)	Computers Prizmo, Easy Writer, SayHi, iTranslate, Dragon Search, Voice Reader Web, Ruzzle, Hang Man, Dasiy Reader, and Vod	Passage reading, reading fluency and reading comprehension	Smartphones and tablets	Trained special education teachers	5 weeks 4 sessions per week 18 sessions (<i>M</i>) 40-60 minutes per session (47 minutes= <i>M</i>)

Schneider et al. (2016)	MindPlay Virtual Reading Coach	Phoneme-grapheme knowledge/ phonics, phonemic awareness, fluency, vocabulary, comprehension, print concepts, and grammar	Computer	Learners independent	School year 4 sessions per week 30 minutes per session
Musti-Rao et al. (2015)	The Sight Words: Kids Learn App	Sight word reading	iPad	Teacher (study 1) Learners independent (study 2)	Study 1: 13 weeks 3 sessions per week 17-33 sessions per child 10 minutes per session Study 2: 12 weeks 21-30 sessions 10 minutes per session
Larabee et al. (2014)	Build a Word – Easy Spelling with Phonics	Phoneme-grapheme knowledge/ phonics, word reading and pseudoword reading	iPad	Researcher	2 weeks 4 sessions per week 9 sessions 7.65 minutes per session (<i>M</i>)
Lysenko & Abrami (2014)	Combined ABRACADABRA and ePearl	Phoneme-grapheme knowledge/ phonics, word reading, reading and listening comprehension, and reading fluency Meta-cognition in reading and writing	Computer	Trained classroom teachers	1 school year 2 hours per week
Walcott et al. (2014)	Earobics	Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading	Computer	Researcher (2 days per week) and teacher (2 days per week)	Study 1: 4 weeks 4 sessions per week 20 minutes per session Study 2: 5 weeks 4 sessions per week 20 minutes per session
Ecalte et al. (2013)	ChassyMo Oppositions Phonologiques	Word reading and phonological awareness (grapho-syllabic word processing) Word reading and phonological awareness (grapho-phonemic word processing)	Computer	Learners independent	10 weeks 4 sessions per week 30 minutes per session (10 hours of total intervention)
Fälth et al. (2013)	Omega-Interactive Sentences (comprehension training) COMputerized PHONological Training (phonological training)	Word reading, sentence reading, vocabulary and reading comprehension Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading	Computer	Special education teacher	25 sessions 15-20 minutes per session (7 hours 41 minutes of total intervention (<i>M</i>))
Kyle et al. (2013)	English GraphoGame Phoneme English GraphoGame Rime	Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading – tasks focusing on phoneme level	Computer	Learners independent	12 weeks 5 sessions per week 10-15 minutes per session (11 hours of total intervention (<i>M</i>))

		Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading – tasks focusing on rime level			
Potocki et al. (2013)	LoCoTex	Reading comprehension	Computer	Learners independent	5 weeks 4 sessions per week 30 minutes per session (10 hours of total intervention)
Gustafson et al. (2011)	COMputerized PHOnological Training (phonological training programme) Omega-Interactive Sentences (comprehension training programme) Combined COMputerized PHOnological Training and Omega-Interactive Sentences (combined training)	Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading Word reading, sentence reading, vocabulary and reading comprehension Phoneme-grapheme knowledge/ phonics, phonological awareness, word reading, sentence reading and reading comprehension	Computer	Trained special education teachers	25 sessions 10-25 minutes per session (Total intervention time - Phonological training 422.2 minutes (M); Comprehension training 443.5 minutes (M); Combined training 480.9 minutes (M); Ordinary special instruction 502.7 minutes (M))
Kim et al. (2011)	Read 180	Phoneme-grapheme knowledge/ phonics, phonological awareness, word reading, fluency, vocabulary and reading comprehension	Computer	Trained teachers	23 weeks 4 sessions per week 60 minutes per session
Saine et al. (2011)	GraphoGame	Phoneme-grapheme knowledge/ phonics, phonological awareness and word reading	Computer	Learners independent	28 weeks 4 sessions per week 45 minutes per session (66 hours of total intervention)
Yaw et al. (2011)	Sight words taught on computer screen	Sight word reading	Computer	Researcher	16 sessions 2-4 sessions per week 3.33 minutes per session
Kim et al. (2010)	Read 180	Phoneme-grapheme knowledge/ phonics, phonological awareness, word reading, fluency, vocabulary and reading comprehension	Computer	Trained teachers	23 weeks 4 sessions per week 60 minutes per session
Torgesen et al. (2010)	Read, Write and Type (RWT)	Phoneme-grapheme knowledge/ phonics, phonological awareness, word reading, passage reading, spelling/writing/typing	Computer	Trained teachers (half the time) and learners independent (half the time)	8 months 4 sessions per week 50 minutes per session (80 hours of total intervention)

	The Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech (LIPS)	Phoneme-grapheme knowledge/ phonics, phonological awareness (an oral motor/ articulation awareness approach), word reading, passage reading, spelling/writing			
Ecalte et al. (2009)	A whole word recognition approach (control group) A syllabic unit word recognition approach (treatment group)	Word reading Phonological awareness (syllable level) and word reading	Computer	Learners independent	5 weeks 2 sessions per day 15 minutes per session (10 hours of total intervention)
Macaruso & Rodman (2009)	Lexia Strategies for Older Students	Phoneme-grapheme knowledge/ phonics, phonological awareness, word reading, reading fluency, reading comprehension	Computer	Learners independent	50 sessions (<i>M</i>) 8 months 2-3 sessions per week 20-30 minutes per session
Mills-Tettey et al. (2009)	The Reading Tutor	Phoneme-grapheme knowledge/ phonics, word reading, passage reading for reading fluency	Computer	Learners independent	9 weeks 30 minutes per session 5 sessions per week Variable attendance and usage
Savage et al. (2009)	ABRACADABRA	Phoneme-grapheme knowledge/ phonics, word reading, reading fluency, reading comprehension, listening comprehension and writing	Computer	Trained facilitator	4 sessions per week 20 minutes per session
Given et al. (2008)	Fast ForWord	Phoneme-grapheme knowledge/ phonics, phonological awareness, receptive and expressive language, word reading and reading comprehension	Computer	Learners independent	12 weeks 5 sessions per week 88 minutes per day (88 hours of total intervention)

Note. (M) refers to the mean. Papers are ordered chronologically by year and alphabetically within years.

Appendix A4

Table 4: Outcome measures and results of the studies included in the ICT-based reading intervention literature review

Study	Outcome measures	Results
Mize et al. (2019)	Informal measures of word reading accuracy and fluency	All children's reading accuracy and fluency increased (the number of correct words read per minute) as a result of the intervention.
Barber et al. (2018)	Informal measures of reading fluency and comprehension	The children demonstrated improvements in reading fluency and comprehension as a result of the intervention.
Messer & Nash (2018)	Standardised measures of phonological awareness, phonological short-term memory, executive loaded working memory, naming speed, decoding and spelling	The children in the experimental group had significantly higher scores than the waiting list control group on measures of decoding, phonological awareness, naming speed, phonological short-term memory and executive loaded working memory. The effect size gains from pre- to post-test were large.
Solheim et al. (2018)	Standardised measures of word reading, sentence reading and spelling	Both treatment groups had statistically significantly higher word reading, sentence reading and spelling skills than the control group at post-test, a follow up one year later and a follow up two years later.
Bennett et al. (2017)	Non-standardised measures of reading fluency and comprehension	Reading fluency and comprehension improved for practiced and novel passages during intervention and on the two week and one month follow ups.
Madden & Slavin (2017)	Standardised assessments of word reading, fluency and comprehension.	For both studies, reading skills (word reading, fluency and comprehension) improved significantly in intervention groups compared to control groups. Effect sizes were larger in grade 2 and 3 compared to grade 1.
Özbek & Girli (2017)	Informal measures of reading fluency and interviews	The intervention improved the reading fluency of the learners. Qualitative findings were that learners' views about the intervention were generally positive and parents believed the intervention was effective.
van de Ven et al. (2017)	Standardised tests of pseudoword reading, word reading, text reading, receptive vocabulary and a reading motivation questionnaire	Intervention effects were found for pseudoword reading and reading fluency. No effects were found on word reading or reading motivation.
Abrami et al. (2016)	Norm-referenced tests of reading, reading vocabulary, reading comprehension, listening comprehension and end-of-year examination results in English and other subjects taught in English including Social Studies, Mathematics and Science	Children in the intervention group made significant gains in reading comprehension and listening comprehension compared to the control group. Medium effect sizes were found. There was no significant difference between the groups on the other norm-referenced measures. Children in the intervention group outperformed children in the control group in the four exams. A small effect size was found.
El Zein et al. (2016)	Informal measure of reading comprehension (identifying the main idea of a paragraph)	The iPad and teacher-directed instruction were both associated with improvements in reading comprehension (identifying the main idea of a paragraph). Teacher-directed instruction was more effective than iPad instruction for increasing the accuracy of responses to main idea comprehension questions.
Lindeblad et al. (2016)	Standardised measures of word reading, sentence reading, non-word reading, reading comprehension and questionnaires	There was a statistically significant improvement in reading and reading comprehension between the pre- and post-test measures. At a one-year follow-up, the children in the intervention group had developed reading skills at a rate equivalent to non-impaired children, suggesting that the programme increased reading ability. The follow-up questionnaire results indicated self-reported increase in motivation and a teacher and parent reported increase in self-confidence and independence in learning.

Schneider et al. (2016)	Standardised measures of word reading, pseudoword reading, word spelling, pseudoword spelling, and word reading fluency	Children in the intervention group improved significantly more than children in the control group on measures of word spelling, non-word spelling, and word fluency. The effect sizes for word reading fluency and non-word spelling were large. The effect size for real word spelling was medium. Significant effects of the intervention were not detected for non-word reading and real word reading but there were non-significant differences favouring learners in the treatment group.
Musti-Rao et al. (2015)	Informal measures of sight word reading and standardised measures of oral reading fluency in addition to observational measures of academic engagement during iPad activities for study 2	For both studies, the intervention resulted in improvements in sight word reading. However, gains were not achieved for oral reading fluency. There were consistently high levels of engagement with iPad intervention compared to during independent reading time.
Larabee et al. (2014)	Informal measures of phoneme-grapheme knowledge, words and pseudowords	There was no difference between the iPad instruction and instruction with typical materials on letter knowledge and word reading. The impact of the iPad intervention on learners' reading performance was mixed (there was not a consistent pattern).
Lysenko & Abrami (2014)	Standardised measures of vocabulary, reading comprehension, listening comprehension and writing	For study 1, the intervention resulted in significant gains in vocabulary and reading comprehension but not listening comprehension or writing. A small effect size was found. For study 2, the intervention resulted in significant gains in vocabulary, reading comprehension and writing but not listening comprehension. A medium effect size was found.
Walcott et al. (2014)	Standardised measures of reading fluency and phoneme segmentation and researcher-developed observational measures for attention-to-task	For study 1 and study 2, all participants had improvements in oral reading fluency, phoneme segmentation, and attention-to-task relative to their baseline functioning. Medium effect sizes were found.
Ecalte et al. (2013)	Standardised assessment of word reading for study 1. Standardised assessment of silent word recognition, aloud word reading, and reading comprehension for study 2	For study 1, the children from the grapho-syllabic training group significantly outperformed children from the grapho-phonemic training and control group in word reading. For study 2, children in the grapho-syllabic training group and the grapho-phonemic training group both showed gains on silent word recognition, aloud word reading and reading comprehension. The grapho-syllabic training group outperformed the grapho-phonemic training group but not significantly.
Fälth et al. (2013)	Standardised measures of sight word reading, word reading, pseudoword reading, phonological awareness (deletion) and reading comprehension	Statistically significant improvements were made for all groups on all measures. Typically developing readers made the greatest improvements followed by (in order from highest to lowest gains) the combined treatment group, the word phonological group, the comprehension group, and the regular special instruction group.
Kyle et al. (2013)	Standardised measures of reading (single word reading, sight word reading, pseudoword reading); spelling (single word spelling); and phonological awareness (phoneme deletion and rhyme discrimination)	Both games lead to improvements in reading, spelling and phonological awareness skills compared to the control group and the gains were maintained at a four-month follow-up. Medium to large effect sizes were found for both the interventions.
Potocki et al. (2013)	Non-standardised measures of listening comprehension, reading comprehension and comprehension monitoring; standardised measure of receptive vocabulary	The programme improved children's listening and reading comprehension. The experimental group progressed more between the pre-test and the two post-tests sessions and the difference between the groups was significant at the second post-test, (11 months after the training phase). For vocabulary and comprehension monitoring, a significant difference between the experimental group and the control group was only present at the first post-test and this effect disappeared one year after the end of the intervention.

Gustafson et al. (2011)	Standardised measures of sight word reading, word decoding, pseudoword reading, reading comprehension and passage comprehension	All three interventions improved reading skills and the combined intervention was the most effective. The three intervention groups improved their reading skills at least as much as the comparison groups (ordinary special instruction and typical readers). The phonological training group showed large effects on reading comprehension, word decoding, and sight word reading; a large to moderate effect on passage comprehension; and a moderate to small effect on pseudoword reading. Comprehension training resulted in large effects on passage comprehension and sight word reading, large to moderate effects on word decoding and pseudoword reading, and moderate to large effects on reading comprehension. Combined training resulted in large effects on all five measures. Ordinary special instruction obtained a large effect on sight word reading, a large to moderate effect on word decoding, moderate to large effects on reading comprehension and passage comprehension, and a moderate to small effect on pseudoword reading. Typical readers showed a moderate effect on reading comprehension, moderate to large effects on word decoding and sight word reading, and moderate to small effects on passage comprehension and pseudoword reading.
Kim et al. (2011)	Standardised measures of reading comprehension, spelling, vocabulary, reading accuracy and reading rate	There was a statistically significant difference between the intervention and control groups on measures of vocabulary and reading comprehension. There were no statistically significant differences between the intervention and control group on measures of spelling, reading accuracy or reading rate.
Saine et al. (2011)	Standardised measures of letter knowledge, reading accuracy, fluency and spelling	Children in the computer-based intervention group improved during grade 1 and continued to progress similarly in the follow-ups conducted 12 months and 16 months after the intervention had ended. The overall gains in the computer-assisted intervention were significant for letter knowledge, decoding, accuracy, fluency and spelling. Children in the regular remedial intervention group also made gains but to a lesser extent.
Yaw et al. (2011)	Informal measures: Dolch sight word lists	Intervention improved sight word reading significantly compared to multiple baseline measures.
Kim et al. (2010)	Standardised measures of sight word reading, vocabulary, reading comprehension, phonetic decoding, reading accuracy and reading rate	There was no statistically significant difference between the reading performance of the intervention and control groups on post-test measures of sight word reading, phonetic decoding, vocabulary and comprehension. Children in the intervention group performed significantly higher on measures of reading fluency (accuracy and rate) but this was only found for children in grade four.
Torgesen et al. (2010)	Standardised measures of word accuracy/fluency, phonemic decoding accuracy/ fluency, text reading accuracy/fluency, reading comprehension, phonological awareness, rapid naming, and spelling	Reading outcomes were slightly stronger in the group which received the LIPS intervention compared to the group that received the RWT intervention, but this was not statistically significant. Learners who received intervention (both the LIPS and the RWT groups) showed significantly higher outcomes in phonological awareness, rapid naming, phonemic decoding/ fluency, word reading accuracy/ fluency, spelling and reading comprehension at the end of grade one. However, at the one-year follow-up the learners in the intervention groups had higher scores in all areas than learners in the control group but the gains were only statistically significant for

		phoneme decoding, rapid naming and spelling.
Ecalte et al. (2009)	Non-standardised tests of word recognition, reading words aloud, and word spelling	The treatment group (emphasising syllabic units) significantly outperformed the control group at all three post-tests (immediately post intervention, 4 months post intervention and 9 months post intervention) on measures of word recognition, reading words aloud and word spelling. Large treatment effects were observed.
Macaruso & Rodman (2009)	Standardised measures of single word reading, pseudoword reading, reading fluency, reading vocabulary, reading comprehension, listening comprehension, and spelling	Intervention learners showed significantly larger gains than control learners on measures of decoding skills. Intervention learners showed a trend towards greater gains than control learners on word reading. Both groups had improved reading comprehension whereas no gains were found for vocabulary, fluency and spelling.
Mills-Tetty et al. (2009)	Non-standardised measures of reading fluency and word spelling	The children from a public school in a low-income community improved significantly more than children in the control group in reading fluency and spelling. The reading fluency of children from an informal educational programme for highly disadvantaged children improved significantly more than that of the control group. However, children from this treatment group did not make significantly higher gains in spelling. There were no significant differences in gains between children from a private school in a middle-income community and the control group.
Savage et al. (2009)	Standardised measures of letter-sound knowledge, listening comprehension, word reading, word meaning, sentence comprehension, passage comprehension, reading fluency, pseudoword reading, and phonological awareness (deletion, blending)	For the analytic phonics programme, there were significant improvements in letter knowledge. For the synthetic phonics programme, there were significant improvements in phonological awareness, listening comprehension, reading comprehension, and reading fluency. Both interventions had a significant impact on literacy at post-test and follow-up.
Given et al. (2008)	Standardised assessment of phonological awareness, reading, spelling, receptive language and expressive language	The treatment group did not differ significantly from the control groups on any of the measures, indicating FastForWord was not more effective in improving language and reading skills compared to regular classroom instruction and another programme.

Papers are ordered chronologically by year and alphabetically within years.

The Virtual Reading Gym: Image Appendices

*All images are subject to copyright. Images are the intellectual property of the Virtual Reading Gym (Pty) Ltd.

Appendix A5

Image 1

Image removed after examination of the thesis with permission from the faculty

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Appendices: Chapter Three

Appendix B1: Retrospective study assessment battery

Tests of decoding and single word reading:

1. The Test of Word Reading Efficiency (TOWRE) (Wagner, Torgesen, & Rashotte, 1999):
Sight word reading efficiency sub-test
2. The Wechsler Individual Achievement Test – 2nd edition (WIAT-II) (Wechsler, 2001): Word
reading subtest
3. The WIAT-II: Pseudoword decoding subtest

Tests of rapid naming

1. The Rapid Automatized Naming and Rapid Alternating Stimulus Test (RAN/RAS) (Wolf &
Denckla, 2005): Objects subtest
2. The RAN/RAS: Letters subtest

Tests of contextual reading for rate, accuracy and comprehension:

1. The WIAT-II: Reading comprehension subtest
2. The Burns and Roe Informal Reading Inventory – 8th edition (Burns & Roe, 2010)

Test of vocabulary:

1. The British Picture Vocabulary Scale (Dunn, Whetton, & Burley, 1997)

Appendix B2: Ethical approval letter



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room E53-46 Old Main Bldg
Groota Schuur Hospit
Observatory 79:
Telephone [021] 406 66:
Email: shurrita.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

22 June 2018

HREC REF: 363/2018

A/Prof Michelle Pascoe
Health and Rehab
F-Floor, OMB

Dear A/Prof Pascoe

PROJECT TITLE: THE EFFECTIVENESS OF THE VIRTUAL READING GYM ONLINE INTERVENTION FOR GRADE 3 TO 7 LEARNERS WITH READING DIFFICULTIES (Masters Candidate - Ms J Dean) sub-study linked to 154/2016

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 June 2019.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate Institutional approval, where necessary, before the research may occur.

The HREC acknowledges that the student, Jessica Dean will also be involved in this study.

Yours sincerely

Signature Removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

Appendix B3: Western Cape Department of Basic Education permission letter



Directorate: Research

Audrey.wyngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20180704-3991

ENQUIRIES: Dr A T Wyngaard

Dr Michele Pascoe
F45 Old Main Building, UCT
Groote Schuur Hospital
Observatory
7925

Dear Dr Michele Pascoe

RESEARCH PROPOSAL: THE EFFECTIVENESS OF THE VIRTUAL READING GYM (VRG) ONLINE INTERVENTION FOR GRADE 3 TO 7 LEARNERS WITH READING DIFFICULTIES

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **17 July 2018 till 28 September 2018**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000**

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wyngaard

Directorate: Research

DATE: 05 July 2018

Lower Parliament Street, Cape Town, 8001
tel: +27 21 467 9272 fax: 0865902282
Safe Schools: 0800 45 46 47

Private Bag X9114, Cape Town, 8000
Employment and salary enquiries: 0861 92 33 22
www.westerncape.gov.za

Appendix B4: Letter to principal of school



School of Health and Rehabilitation Sciences

Faculty of Health Sciences

[Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy](#)

F45 Old Main Building, Groote Schuur Hospital,

Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Dear _____

RE: Information about research study and consent for participation of learners and staff

Research topic

My name is Jessica Dean and I am a speech-language therapist completing a master's degree at the University of Cape Town. I am conducting a study on the effectiveness of an online intervention called The Virtual Reading Gym (VRG) for grade three to seven children with reading difficulties in order to fulfil the requirements of my degree. I am also investigating learners' and adult reading partners' attitudes towards the VRG and their experiences related to the intervention. I have been granted permission to complete this study by the University of Cape Town Health Sciences Human Research Ethics Committee (reference number 363/2018).

Reason for the study

There is limited local information about how children with reading difficulties respond to intervention. Such information is helpful for speech-language therapists, teachers and parents who want to provide input which will improve children's reading skills. This study aims to generate information related to whether the VRG intervention is effective and what those who use it think and feel about the programme.

Who can participate?

Your school is being invited to participate in the study. Your school must meet the following criteria to participate: (a) English is the language of learning and teaching or English is one of the languages of instruction in a dual language school; (b) access to computers with internet and sound output; (c) school, parental and learner willingness for learners to be excused from non-core academic activities

or to attend intervention before or after the school day and; (d) be recognised as a school for learners with special educational needs (LSEN) or have a division or class for LSEN.

The study would need a total of twenty learners and between one and ten speech-language therapist staff members (to act as reading partners) from your school to participate. However, at least 50 learners (or more if necessary) will need to be assessed until twenty suitable learner candidates are found.

The learners with reading difficulties from your school must have/be: (a) identified by their teacher as having a grade two or higher reading level; (b) difficulties with reading compared to grade level; (c) functional English skills (being able to understand, speak and learn in English even if English is not their home language); (d) normal vision; (e) normal hearing; and (f) adequate attention, behaviour and cooperation. Unfortunately, any learners who are receiving any one-on-one or small group reading intervention at school or outside of school will not be able to participate in the study. However, if they have been in reading programmes before the study or are on a waiting list for reading intervention, they will not be excluded.

The reading partners must have/be: (a) a speech-language therapist (SLT) at the LSEN school who has a degree in speech-language therapy from a university or an SLT working as a research assistant for the study who has a degree in speech-language therapy from a university and is an experienced clinician for school-aged children; (b) oral English proficiency; (c) English reading proficiency; (d) normal vision; (e) normal hearing; and (f) motivation and commitment to working with a child with reading difficulties for a school term. The reading partners must not be providing the learners with reading difficulties (who participate in the therapy or control group) any form of individual or small group reading support at school or outside of school (except to the children they support during the VRG therapy).

Outline of the study procedure

- After consent is provided by yourself, the study would begin at your school.
- An information session would be held at the school for the teachers and speech-language therapists to inform them about the study and to begin the process of recruiting participants.
- Once consent is obtained from the learners' parents and the learners themselves, the learners' school folders will be reviewed by the researcher to determine whether they meet the criteria mentioned above.
- The learners who meet the criteria will then have their language and literacy skills assessed with a battery of formal and informal assessments at the school by the researcher, a qualified and experienced speech-language therapist. The assessment will take place in a quiet room and may take 2-3 sessions depending on interruptions and learner distractibility. The assessments will be

audio recorded. Once the accuracy of the assessment scores has been checked, the audio recordings will be deleted.

- After consent is obtained from adult reading partners, they will be given a video-based training session related to their intervention roles. The session will be approximately one hour long, be provided by the researcher and take place at the school.
- The study will use a design where the data will be analysed by pairing learners with similar assessment scores together. Once the assessments have been conducted, the learners will be paired. Any learners who cannot be formed into pairs will not participate in the study. However, all parents of learners who are assessed will be provided with a brief assessment report and will be referred to the speech-language therapists at the school if therapy is recommended.
- Learners who have been paired will be placed in one of two groups: half of the learners will be placed in the therapy group and the other half will be in the control group. The researcher, the teachers and the parents will not choose who is in the therapy or control group. This will be done through a randomisation process. The learners in the therapy group will get the VRG intervention and be supported by their allocated reading partner. The learners in the control group will not get the VRG intervention but will continue as normal with regular activities.
- Each learner in the therapy group and his/her reading partner will then participate in the VRG intervention which will consist of 20-minute sessions three times per week for a total of ten weeks. The programme was designed to be motivating and targets all aspects of reading (e.g. accuracy, rate, vocabulary and comprehension).
- The session times will be negotiated with the school and every effort will be made to reduce disruptions to the school schedule by having all sessions occur during non-core academic activities (e.g. before or after school).
- The reading partners will be given the role of ensuring that learners participate in the intervention at the allocated times and for addressing any logistical issues that may arise.
- Once the VRG intervention is completed, the learners from the therapy and control groups will be assessed by a qualified and experienced research assistant speech-language therapist at the school. The same assessments and assessment procedure as described earlier will be used.
- Learners allocated to the control group will be given access to a VRG online account to use at home the school term following the one in which data will be collected.
- Learners who were in the intervention group will be individually interviewed by their reading partner for a maximum of 15 minutes each. This will be done to collect information related to what the children thought and felt about the VRG and experiencing the intervention. The interviews will be audio recorded and transcribed. Once the accuracy of the transcriptions has been checked, the audio recordings will be deleted.
- Reading partners will be individually interviewed by the researcher. The interviews will be approximately 15 minutes long and will focus on gathering information related to what the adult

thought and felt about the VRG and offering support to a child with reading difficulties. The interviews will be audio recorded and transcribed. Once the accuracy of the transcriptions has been checked, the audio recording will be deleted.

- Once the final research report has been written, the school, the parents, the learners and the reading partners will have the opportunity to access a summary of the study's findings.

Risks

There are no known risks related to participating in the study. The VRG intervention will be provided to the children free of charge. The VRG training workshop for the reading partners will not cost the individuals any money. The parents', learners' and reading partners' decision to take part or to refuse to take part in the study will not have any influence on their employment, schooling or therapy services they are receiving or awaiting.

Benefits

The learners who receive the VRG intervention may benefit from the reading programme and the support of a reading partner. The reading partners may benefit from the training workshop and having the opportunity to provide support to a learner with reading difficulties. The learners and the reading partners from the school will not be paid or reimbursed in any way for participating. The learners who are assessed but cannot be paired will be provided with an assessment report outlining their strengths and weaknesses related to the tested areas. The learners in the control condition will be provided with two assessment reports (one for their initial assessment and one for the assessment which occurs after the children in the intervention group have finished the VRG intervention sessions).

Ethical considerations

Participation in this study is voluntary. Participation can be withdrawn at any time without there being any negative consequences. All information obtained will be kept private and confidential. The research report will not reveal any personal information related to the study participants. The collected data will be stored on password protected devices and in safe storage units and will only be accessible to the researcher and supervisors.

Thank you

I am requesting to conduct this study at your school. Thank you for considering this request.

If you have any queries or concerns, please do not hesitate to contact me or one of my research supervisors. The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted on 021 496 63338 in case participants have any questions regarding their rights and welfare as research subjects in the study.

Kind regards,

Jessica Dean (speech-language therapist and master's degree student)

dnxjes002@myuct.ac.za

060 848 3569

Supervisor: Dr Michelle Pascoe

michelle.pascoe@uct.ac.za

083 379 8746

Co-supervisor: Jane le Roux

jane.leroux@uct.ac.za

073 2044 670

Head of research
ethics committee: Prof Marc Blockman

marc.blockman@uct.ac.za

021 406 6496

Appendix B5: Letter and informed consent form for SLT reading partners



School of Health and Rehabilitation Sciences

Faculty of Health Sciences

Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy

F45 Old Main Building, Groote Schuur Hospital,

Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Dear Sir/ Madam

RE: Information about research study and consent for participation

Research topic

My name is Jessica Dean and I am a speech-language therapist completing a master's degree at the University of Cape Town. I am conducting a study on the effectiveness of an online intervention called The Virtual Reading Gym (VRG) for grade three to seven children with reading difficulties in order to fulfil the requirements of my degree. I am also investigating learners' and adult reading partners' attitudes towards the VRG and their experiences related to the intervention. I have been granted permission to complete this study by the University of Cape Town Health Sciences Human Research Ethics Committee (reference number 363/2018).

Reason for the study

There is limited local information about how children with reading difficulties respond to intervention. Such information is helpful for speech-language therapists, teachers and parents who want to provide input which will improve children's reading skills. This study aims to generate information related to whether the VRG intervention is effective and what those who use it think and feel about the programme.

Who can participate?

The study would need between one and five speech-language therapists from your school to participate. I am inviting you to participate as a reading partner for a learner/ learners with reading difficulties. To participate, you must have/be: (a) a speech-language therapist (SLT) at the LSEN school who has a degree in speech-language therapy from a university or an SLT working as a

research assistant for the study who has a degree in speech-language therapy from a university and is an experienced clinician for school-aged children; (b) oral English proficiency; (c) English reading proficiency; (d) normal vision; (e) normal hearing; and (f) motivation and commitment to working with a learner with reading difficulties for a school term. The reading partners must not be providing the learners who participate in the study (in the intervention or control condition) with reading difficulties any form of individual or small group reading support at school or outside of school (except to the learners they support during the VRG therapy).

Outline of the study procedure

- An information session will be held at the school for the teachers and speech-language therapists to inform you about the study.
- After you have provided consent (should you choose to do so), you will be asked to provide a copy of your curriculum vitae for the researcher to review.
- If you meet the criteria for participation, you will attend a video-based training session related to your role in supporting a child with reading difficulties. The session will be approximately one hour long and be held at the school. It will be provided by the researcher.
- You will then be randomly allocated to one or more learners with reading difficulties from the school, depending on your availability and schedule.
- You and each learner you have been allocated will then participate in the VRG intervention which will consist of 20-minute sessions three times per week for a total of ten weeks.
- The session times will be negotiated with the school and every effort will be made to reduce disruptions to your schedule. The sessions will occur during non-core academic learner activities or before or after school.
- If you are the research assistant for the study, you will interview the learners you were allocated for the intervention after the VRG intervention is completed. You will be given a list of questions to ask the learners related to what they thought and felt about the VRG intervention and their experiences. The interview will be approximately 15 minutes long. If you are a school speech-language therapist, the research assistant will interview the learners you were allocated.
- Once the VRG intervention is completed, you will be individually interviewed by the researcher. The interview will be approximately 15 minutes long and will focus on gathering information related to what the you thought and felt about the VRG and offering support to a learner with reading difficulties. The interviews will be audio recorded and transcribed. Once the accuracy of the transcriptions has been checked, the audio recording will be deleted.
- Once the final research report has been written, you will have the opportunity to access a summary of the study's findings.

Risks

There are no known risks related to participating in the study. The VRG training workshop will not cost you any money. Your decision to take part or to refuse to take part in the study will not have any influence on your employment.

Benefits

You may benefit from the training workshop and having the opportunity to provide support to a learner with reading difficulties. If you are a speech-language therapist at the school, you will not be paid or reimbursed in any way for participating.

Ethical considerations

Participation in this study is voluntary. Participation can be withdrawn at any time without there being any negative consequences. All identifying information obtained will be kept private and confidential. The collected data will be stored on password protected devices and in safe storage units. A research report will be published but it will not reveal any personal information related to you.

Thank you

I am inviting you to participate as a reading partner for my study. Thank you for considering this request.

Please complete the attached consent form if you would like to participate in the study.

If you have any queries or concerns, please do not hesitate to contact me or one of my research supervisors. The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted on 021 496 63338 in case participants have any questions regarding their rights and welfare as research subjects in the study.

Kind regards,

Jessica Dean (speech-language therapist and master's degree student)

dnxjes002@myuct.ac.za

060 848 3569

Supervisor: Dr Michelle Pascoe

michelle.pascoe@uct.ac.za

083 379 8746

Co-supervisor: Jane le Roux

jane.leroux@uct.ac.za

073 2044 670

Head of research
ethics committee:

Prof Marc Blockman

marc.blockman@uct.ac.za

021 406 6496

Consent form for reading partner

Effectiveness of an online reading intervention for children with reading difficulties

I, _____ have read (or had read to me by) _____ the information sheets. I understand what is required of me. I **do/do not** consent to participate in the study (circle your response). I have had the opportunity to ask questions and all of my questions have been answered. I do not feel that I am being forced to take part in this study and I am participating of my own free will. I know that I can withdraw my participation at any time if I so wish and that it will have no bad consequences for me.

Name

Signature

Date and place

Appendix B6: Letter and informed consent form for parents/ legal guardians



School of Health and Rehabilitation Sciences

Faculty of Health Sciences

Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy

F45 Old Main Building, Groote Schuur Hospital,

Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Dear Parent /Guardian

RE: Information about research study and consent for your child to participate

Research topic

My name is Jessica Dean and I am a speech-language therapist completing a master's degree at the University of Cape Town. I am conducting a study on the effectiveness of an online intervention called The Virtual Reading Gym (VRG) for grade three to seven children with reading difficulties in order to fulfil the requirements of my degree. I am also investigating learners' and adult reading partners' attitudes towards the VRG and their experiences related to the intervention. I have been granted permission to complete this study by the University of Cape Town Health Sciences Human Research Ethics Committee (reference number 363/2018).

Reason for the study

There is limited local information about how children with reading difficulties respond to intervention. Such information is helpful for speech-language therapists, teachers and parents who want to provide input which will improve children's reading skills. This study aims to generate information related to whether the VRG intervention is effective and what those who use it think and feel about the programme.

Who can participate?

Your child has been suggested by his/her teacher as meeting the criteria for the study. The study needs twenty children to participate. In order to participate, your child must have/be: (a) identified by their teacher as having a grade two or higher reading level; (b) difficulties with reading compared to grade level; (c) functional English skills (being able to understand, speak and learn in English even if

English is not their home language); (d) normal vision; (e) normal hearing; and (f) adequate attention, behaviour and cooperation. Unfortunately, any children who are receiving any one-on-one or small group reading intervention at school or outside of school will not be able to participate in the study. However, if they have been in reading programmes before the study or are on a waiting list for reading intervention, they will not be excluded.

Outline of the study procedure

- Should you provide consent and your child subsequently provide verbal assent to the researcher, your child's school folder will be reviewed by the researcher to ensure he/she meets the criteria mentioned above.
- After your consent and your child's verbal assent is provided, your child's language and literacy skills will be assessed by the researcher, a qualified and experienced speech-language therapist. The assessment will take place in a quiet room and may take 2-3 sessions depending on interruptions and learner distractibility. The assessments will be audio recorded. Once the accuracy of the assessment scores has been checked, the audio recordings will be deleted.
- The study will use a design where the data will be analysed by pairing learners with similar assessment scores together. Once the assessments have been conducted, the researcher will determine whether any other child's results are similar enough to your child's results to be included in the study. If your child's results are not similar enough to any other child's results, your child will not be able to participate in the study. However, you will receive an assessment report based on your child's results and your child will be referred to the speech-language therapists at the school if the results indicate that therapy is recommended.
- If your child's results are similar enough to another child's results, he/she will be able to participate in the next phase of the study. Your child will then be placed in one of two groups: half of the children will be placed in the therapy group and the other half will be in the control group. The researcher and the school staff members will not choose who is in the therapy or control group. This will be done through a randomisation process.
- If your child is assigned to the therapy group, he/she will get the VRG intervention and be supported by their allocated reading partner, who will be a speech-language therapist who works at the school or a speech-language therapist research assistant.
- If your child is assigned to the control group, he/she will not get the VRG intervention but will continue as normal with regular school activities. Your child will, however, be given a VRG account to use at home in the term following the one used for the study's data collection.
- After assessment and the random assignment, each child who is in the therapy group and his/her reading partner will participate in the VRG intervention which will consist of 20-minute sessions three times per week for a total of ten weeks. The programme was designed to be motivating and targets all aspects of reading (e.g. accuracy, rate, vocabulary and comprehension).

- The session times will be negotiated with the school and every effort will be made to reduce disruptions to the school schedule. The sessions will occur during non-teaching time (e.g. before or after the school day).
- Once the VRG intervention is completed, your child will be assessed (both the children from the therapy and control groups will be assessed). Your child will be assessed by a qualified and experienced research assistant speech-language therapist at the school. The same assessments and assessment procedure as described earlier will be used.
- If your child is in the therapy group, he/she will be individually interviewed by the research assistant speech-language therapist at the school for a maximum of 15 minutes. This will be done to collect information related to what your child thought and felt about the VRG and experiencing the intervention. The interviews will be audio recorded and transcribed. Once the accuracy of the transcriptions has been checked, the audio recordings will be deleted.
- Once the final research report has been written, you and your child will have the opportunity to access a summary of the study's findings.

Risks

There are no known risks related to participating in the study. The VRG intervention will be provided to the children free of charge. Your and your child's decision to take part or to refuse to take part in the study will not have any influence on his/ her schooling or therapy services.

Benefits

If your child is in the therapy condition, he/she may benefit from the VRG reading programme and the support of a reading partner. If your child is not able to participate in the study due to having assessment scores that are not similar enough to any other child's scores, you will be provided with an assessment report outlining their strengths and weaknesses related to the tested areas. If your child is in the control condition, you will be provided with two assessment reports (one for the initial assessment and one for the assessment which occurs after the children in the therapy group have finished the VRG intervention sessions). Additionally, if your child is in the control condition, you will be given a VRG account to use at home in the term following the one used for the study's data collection. You and your child will not be paid or reimbursed for participating.

Ethical considerations

Participation in this study is voluntary. Participation can be withdrawn at any time without there being any negative consequences. All information obtained will be kept private and confidential. The research report will not reveal any personal information related to your or your child. The collected

data will be stored on password protected devices and in safe storage units and will only be accessible to the researcher and supervisors.

Thank you

I am inviting your child to participate in my study. Thank you for considering this request.

Please complete the attached consent form if you would like your child to participate in the study.

If you have any queries or concerns, please do not hesitate to contact me or one of my research supervisors. The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted on 021 496 63338 in case participants have any questions regarding their rights and welfare as research subjects in the study.

Kind regards,

Jessica Dean (speech-language therapist and master's degree student)

dnxjes002@myuct.ac.za

060 848 3569

Supervisor: Dr Michelle Pascoe

michelle.pascoe@uct.ac.za

083 379 8746

Co-supervisor: Jane le Roux

jane.leroux@uct.ac.za

073 2044 670

Head of research
ethics committee: Prof Marc Blockman

marc.blockman@uct.ac.za

021 406 6496

Consent form for parents/ legal guardians

Effectiveness of an online reading intervention for children with reading difficulties

I, _____ (*write your name*) the parent /legal guardian of:

_____ (*write your child's name*) have read or had read to me by
_____ (*write the name of the person who read to you if you did not read yourself*) the information sheets. I understand what is required of my child. I **do/ do not** consent to his/her participation in the study (*circle your response*). I have had the opportunity to ask questions and all of my questions have been answered. I do not feel that my child is forced to take part in this study and I am allowing my child to do so of my own free will. I know that I can withdraw my child's participation at any time if I so wish and that it will have no bad consequences for me or my child.

Signed:


Parent/Legal Guardian 1

Date and place

Parent /Legal Guardian 2

Date and place

Appendix B7: Assent form for learners

 The logo of the University of Cape Town, featuring a shield with a crown on top, a book, and the motto 'SPES BONA'. The shield is surrounded by the university's name in three languages: 'University of Cape Town' at the top, 'iYunivesithi yasekapa' on the left, and 'Universiteit van Kaapstad' on the right.	School of Health and Rehabilitation Sciences
	Faculty of Health Sciences
	Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy
	F45 Old Main Building, Groote Schuur Hospital,
	Observatory 7925
	Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

My name is Jessica Dean and I am a speech therapist. A speech therapist is someone who helps children with their talking, reading and writing. I want to tell you about a research study I am doing. Please stop me along the way if you want to ask any questions. A research study is a way to learn more about something. I would like to find out about how to help children read more easily. I am asking you to join this study because your teacher/parent has told me that you sometimes find it difficult to read. I have already asked your parents / guardian if it is okay for you to join this study and they have said yes. But, you can choose what you want to do, once I have told you a bit more about it.

I will first need to look at your school folder to find out whether the reading programme is right for you. Then, I will need to do some tasks with you to find out a bit more about how you read, write and talk. I will do this by showing you pictures in books and asking you to say what they are, telling you to listen to some things I say and asking you to point to pictures, and to do some reading and writing like what you do in class. I will come to your school and work with you in a quiet room. Your voice will be recorded so that we do not miss out on anything you say. The recording will be deleted once we have checked that we did not miss anything you said. It will probably take two or three visits with you to do all of this.

After that, I will tell you whether you are going to do a reading programme at school or if you are going to continue with normal school activities. If I tell you that you are going to continue with normal activities, you will not take part in the study. If I tell you that you are not going to do the reading programme at school but that you are going to take part in the study, you will be given the chance to do the reading programme at home next term. You will continue normally at school and then ten weeks later a speech therapist I know will come to the school and do the same tasks with you (which I told you about earlier) again and in the same way.

If I tell you that you are going to do the reading programme, I will introduce you to your reading buddy. The reading buddy will be someone at your school who is a speech therapist like me or a speech therapist I know who will come to the school. Your reading buddy will be someone who wants to take time to help children and give them encouragement with their reading. You and your buddy will meet at your school three times each week for about 20 minutes each time. You will work together at the computer or iPad and carry out activities on a programme called The Virtual Reading Gym. After ten weeks, you will stop working on the computer with your buddy, and the speech therapist who I know will come to the school to find out how you read, write and talk by doing tasks like showing you pictures in books and asking you to say what they are, telling you to listen to some things I say and asking you to point to pictures, and to do some reading and writing like what you do in class. She will record your voice so that she does not miss out on anything you say. The recording will be deleted once we have checked that we did not miss anything you said. It will probably take two or three visits from the speech therapist to finish the tasks.

After you have completed these tasks, your reading buddy will interview you (that means ask you some questions) to find out what you thought of the computer programme and the whole experience. Your voice will be recorded in the interview so that I do not miss out on anything you say. The recording will be deleted after what you have said has been written down.

When I tell other people about the study or write up my project I will not use your name. I will give you a random number and use that number when I speak about you. For example, I will say "Participant One liked the VRG". Nobody will know who you are or what you said or did.

There are no prizes for taking part in the study, but it might help your reading. You may like the computer games and getting to know your buddy. The study is very safe.

You can decide if you would like to take part. If you say yes, you can decide to stop being in the study at any time. You can ask me any questions you have about the study now or take some time to think about what you would like to do.

Assent form for learners

I will circle the first box which says “yes” if you would like to be part of the study. I will circle the second box which says “no” if you would not like to be part of the study.

Child’s response to the question, “Would you like to take part in the study?”	
Yes	No

Child’s name

_____ Researcher/ Research Assistant (*please circle your role*)

Name of person who read information sheet
to the child and answered his/her questions

Date: _____

Signature of person who read information sheet
to the child and answered his/her questions

Appendix B8: Assessment battery for prospective study

Tests of decoding and single word reading:

1. The Test of Word Reading Efficiency (TOWRE) (Wagner, Torgesen, & Rashotte, 1999):
Sight word reading efficiency sub-test
2. The Wechsler Individual Achievement Test – 2nd edition (WIAT-II) (Wechsler, 2001): Word
reading subtest
3. The WIAT-II: Pseudoword decoding subtest
4. The WIAT-II: Target words component

Tests of rapid naming

1. The Rapid Automatized Naming and Rapid Alternating Stimulus Test (RAN/RAS) (Wolf &
Denckla, 2005): Objects subtest
2. The RAN/RAS: Letters subtest

Tests of contextual reading for rate, accuracy and comprehension:

1. The WIAT-II: Reading comprehension subtest
2. The WIAT-II: Reading speed component
3. The Burns and Roe Informal Reading Inventory – 8th edition (Burns & Roe, 2010)


Test of vocabulary:

1. The British Picture Vocabulary Scale (Dunn, Whetton, & Burley, 1997)

The VRG in-built measures

1. Reading rate
2. Reading accuracy
3. Reading comprehension

Appendix B9: Interview schedule for learner participants

	School of Health and Rehabilitation Sciences
	Faculty of Health Sciences
	Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy
	F45 Old Main Building, Groote Schuur Hospital, Observatory 7925
	Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

1. What did you like about the Virtual Reading Gym?

Prompt: The Virtual Reading Gym is the name of the reading programme you have been using for the last 10 weeks. You may know it as “your city” or “the city programme”. You have used a computer or iPad during your sessions. *Prompt examples:* Earning ‘points’/ cleaning the city, the reading passages/ ‘stories’, reading the passages to a timer, answering comprehension questions about the stories, the vocabulary cards, the pattern cards, having to read words quickly...

2. What did you dislike (not like) about the Virtual Reading Gym?
3. How was your experience of having a reading buddy (the adult speech therapist who helped you while you used the Virtual Reading Gym)?

Prompts: Did you like having a buddy? Why? Was having a buddy helpful? Why? What did you like your buddy to do? What did you not like your buddy doing?

4. Overall, was using the Virtual Reading Gym a positive (good) or negative (bad) experience for you? Please explain your answer.
5. What is one of the positive (good/ happy) memories you have of using the Virtual Reading Gym?
6. What is one of the negative (bad/ unhappy) memories you have of using the Virtual Reading Gym?
7. Do you think the Virtual Reading Gym helped you to become a better reader? Please explain why or why not.

Prompts: Did it improve your comprehension (understanding of the texts you read); ability to read words better/ more accurately (make fewer mistakes when reading); your fluency (the speed of your reading, the tone of your voice and the smoothness of the sentences); understanding of vocabulary (words which you read)?

8. Would you recommend the Virtual Reading Gym to a friend? Why or why not?

Appendix B10: Letter and parent/ guardian consent form for pilot of learner interview questions



School of Health and Rehabilitation Sciences

Faculty of Health Sciences

Divisions of Communications Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy,
Physiotherapy

F45 Old Main Building, Groote Schuur Hospital,

Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Dear Mr and Mrs _____

RE: Information about research study and consent for participation

My name is Jessica Dean and I am a speech-language therapist completing a master's degree at the University of Cape Town. I am conducting a study on the effectiveness of an online intervention called The Virtual Reading Gym (VRG) for grade three to seven learners with reading difficulties in order to fulfil the requirements of my degree. I am also investigating learners' and adult reading partners' attitudes towards the VRG and their experiences related to the intervention. I have been granted permission to complete this study by the University of Cape Town Health Sciences Human Research Ethics Committee (Reference number...).

Reason for the study

There is limited local information about how children with reading difficulties respond to intervention. Such information is helpful for speech-language therapists, teachers and parents who want to provide input which will improve children's reading skills. This study aims to generate information related to whether the VRG intervention is effective and what those who use it think and feel about the programme.

Who can participate?

Before I interview my study participants, I want to do a pilot (trial run) of my interview questions. I want to do this so that I can determine which questions need to be omitted, added or changed. If you are an adult who has helped a child to complete the VRG programme activities in the last month, you are eligible to participate in the trial interview session.

Outline of the procedure

- After you have provided consent, you will be individually interviewed by the researcher for approximately 15 minutes. The interview will focus on gathering information related to what you thought and felt about the VRG and offering support to a child with reading difficulties.
- The interview will be audio recorded and transcribed. Once the accuracy of the transcription has been checked, the audio recording will be deleted.
- Once the actual study has been completed and the final research report has been written, you will have the opportunity to access a summary of the study's findings.

Risks

There are no known risks related to participating in the trial interview. Your decision to take part or to refuse to take part in the trial interview will not have any negative repercussions.

Benefits

You will not benefit from participating in the trial interview. However, your participation will be beneficial to the research by helping suitable questions to be developed for the study interviews. You will not be paid or reimbursed in any way for participating.

Ethical considerations

Participation in this trial interview is voluntary. Participation can be withdrawn at any time without there being any negative consequences. All information obtained will be kept private and confidential. The collected data will be stored on password protected devices and in safe storage units and will only be accessible to the researcher and supervisors.

Thank you

I am inviting you to participate in the trial interview for my study. Thank you for considering this request.

Please complete the attached consent form if you would like to participate in the pilot interview for my study.

If you have any queries or concerns, please do not hesitate to contact me or one of my research supervisors. The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted on 021 496 63338 in case participants have any questions regarding their rights and welfare as research subjects in the study.

Kind regards,

Jessica Dean (speech-language therapist and master's degree student)

dnxjes002@myuct.ac.za

060 848 3569

Supervisor: Dr Michelle Pascoe

michelle.pascoe@uct.ac.za

083 379 8746

Co-supervisor: Jane le Roux

jane.leroux@uct.ac.za

073 2044 670

Head of research
ethics committee: Prof Marc Blockman

marc.blockman@uct.ac.za

021 406 6496

Effectiveness of an online reading intervention for children with reading difficulties

I, _____ have read


(or had read to me by _____) the information sheet. I understand what is required of me.

I **do/do not** consent to allow my child to participate in the pilot of the interview questions for the study (circle your response). I have had the opportunity to ask questions and all of my questions have been answered. I do not feel that my child is being forced to take part in this pilot and I am allowing my child to participate of my own free will. I know that I can withdraw my child's participation at any time if I so wish and that it will have no bad consequences for me or my child

Signed:

Date:

Appendix B11: Information and assent form for pilot of the learner interview questions

 The logo of the University of Cape Town, featuring a shield with a book and a lamp, surrounded by the university's name in three languages: Afrikaans, English, and Xhosa.	School of Health and Rehabilitation Sciences
	Faculty of Health Sciences
	Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy
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My name is Jessica Dean and I am a speech therapist. A speech therapist is someone who helps children with their talking, reading and writing. I want to tell you about a research study I am doing. A research study is a way to learn more about something. I would like to find out about how to help children read more easily. I am asking you to help me for my study because you have done The Virtual Reading Gym programme before. I have already asked your parents / guardian if it is okay for you to help me and they have said yes. But, you can choose what you want to do, once I have told you a bit more about it.

I would ask you some questions to find out what you thought of the Virtual Reading Gym programme, the adult who helped you and the whole experience. Your voice will be recorded so that I do not miss anything which you say.

When I tell other people about the interview or write up my project I will not use your name. You can choose a pretend name or I can use your initials so that nobody will know who you are or what you said or did.

There are no prizes for taking part in this interview.

You can decide if you would like to take part. If you say yes, you can decide to stop helping me in the study at any time. You can ask me any questions you have about the interview – or take some time to think about what you would like to do.

I will circle the first box which says “yes” if you would like to be interviewed for my study. I will circle the second box which says “no” if you would not like to be interviewed for my study.

Child’s response to the question, “Would you like to take part in the study?”	
Yes	No

Child’s name

Date: _____

Jessica Dean (researcher)

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Appendices: Chapter Four

Appendix C1

Table 12: Retrospective analysis paired samples t-test results on the outcome measures at pre-test

Assessment	95% confidence interval of the difference		t	df	Sig. (2 tailed)
	Lower	Upper			
BPVS	-10.00	0.66	-2.06	9	0.069
Burns and Roe					
Comprehension	-1.55	2.09	0.30	9	0.766
Words per minute	-25.61	2.53	-1.89	9	0.091
Self-corrections	-.87	2.22	0.65	9	0.529
Errors	-2.25	10.39	1.14	9	0.281
RAN/RAS					
Objects	-3.85	4.99	-0.62	9	0.549
Letters	-2.56	8.49	0.56	9	0.585
TOWRE sight word efficiency subtest	-8.69	7.00	0.03	9	0.975
WIAT-II					
Word reading	-6.52	-0.15	-2.33	9	*0.044
Pseudoword decoding	-7.28	1.88	-1.45	9	0.179
Reading comprehension	-9.46	6.05	0.39	9	0.702

Note. Raw scores were used. t is the test statistic. df is the degrees of freedom. Sig (2 tailed) is the p-value corresponding to the given test statistic and degrees of freedom. BPVS is the British Picture Vocabulary Scale. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. Significant results have been indicated with an asterix ().*

Appendix C2

Table 14: Retrospective analysis independent samples t-test results for gain scores on the outcome measures

Assessment	t	df	Sig. (2 tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
						Lower	Upper
BPVS	-0.13	18	0.897	-0.60	4.55	-10.161	8.961
Burns and Roe							
Comprehension	-1.20	18	0.245	-0.95	0.79	-2.61	0.71
Words per minute	1.31	18	0.206	9.80	7.46	-5.87	25.47
Self-corrections	-1.89	18	0.075	-1.90	1.00	-4.01	0.21
Errors	-0.54	18	0.590	-1.60	2.92	-7.73	4.53
RAN/RAS							
Objects	1.25	18	0.225	2.60	2.06	-1.74	6.94
Letters	0.13	18	0.896	0.40	3.01	-5.94	6.74
TOWRE sight word efficiency subtest	-0.68	18	0.500	-2.00	2.90	-8.09	4.09
WIAT-II							
Word reading	0.61	18	0.548	1.30	2.12	-3.16	5.76
Pseudoword decoding	-0.76	18	0.453	-2.20	2.86	-8.22	3.82
Reading comprehension	-0.26	18	0.795	-1.10	4.18	-9.88	7.68

Note. Raw score outcome measure results were used. t is the test statistic. df is the degrees of freedom. Sig (2 tailed) is the p-value corresponding to the given test statistic and degrees of freedom. Mean difference is the difference between the sample means. Std. error difference is the standard error. BPVS is the British Picture Vocabulary Scale. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. Noteworthy results have been highlighted.

Chapter Five: Appendices

Appendix D1

Table 16: Prospective study paired samples t-test results for the outcome measures at pre-test

Assessment	95% Confidence Interval of the Difference		t	df	Sig. (2 tailed)
	Lower	Upper			
BPVS	0.57	12.63	2.47	9	*0.0353
Burns and Roe					
Comprehension	-2.03	1.136	0.64	9	0.5369
Words per minute	-11.70	42.90	1.29	9	1.2928
Self-corrections	-1.42	1.62	0.14	9	0.8853
Errors	-8.87	9.67	0.09	9	0.9244
RAN/RAS					
Objects	-11.60	8.20	0.38	9	0.7066
Letters	-10.15	10.55	0.04	9	0.9661
TOWRE sight word efficiency subtest	-3.18	13.58	-1.40	9	0.194
WIAT-II					
Word reading	-5.66	12.66	0.86	9	0.4097
Pseudoword decoding	-6.18	3.38	0.66	9	0.5245
Reading comprehension	-10.66	8.46	0.26	9	0.8005
Reading target words	-4.67	4.87	0.04	9	0.9632
Reading speed	-216.71	430.31	0.74	9	0.4742

VRG baseline					
Comprehension	-17.61	25.61	0.38	9	0.7019
Words per minute	-17.07	30.47	0.59	9	0.5611
Errors	-8.04	5.04	0.48	9	0.6356

Note. Raw scores were used. t is the test statistic. df is the degrees of freedom. Sig (2 tailed) is the p -value corresponding to the given test statistic and degrees of freedom. BPVS is the British Picture Vocabulary Scale. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. VRG refers to the in-built assessment measures on the Virtual Reading Gym online programme. Significant results have been indicated with an asterix ().*

Appendix D2

Table 18: Prospective study independent samples t-test results for gain scores on the outcome measures

Assessment	t	df	Sig. (2 tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
						Lower	Upper
BPVS	0.27	17	0.789	1	3.679	-6.76	8.76
Burns and Roe							
Comprehension	2.01	18	0.0595	1.5	0.746	-0.067	3.067
Words per minute	2.71	18	*0.0141	-18.70	6.877	-33.15	-4.25
Self-corrections	0.39	18	0.6945	-0.4	1.002	-2.51	1.71
Errors	1.11	18	0.2787	-3.5	3.134	-10.08	3.08
RAN/RAS							
Objects	1.05	18	0.3039	-5.6	5.292	-16.72	5.52
Letters	0.34	18	0.7327	1.00	2.883	-5.06	7.06
TOWRE sight word efficiency subtest	0.42	18	0.6736	1.2	2.802	-4.69	7.09
WIAT-II							
Word reading	0.26	18	0.7934	1.0	3.763	-6.91	8.91
Pseudoword decoding	0.56	18	0.5789	2.3	4.07	-6.25	10.85
Reading comprehension	0.25	18	0.7984	1.1	4.244	-7.82	10.02
Reading target words	0.94	18	0.3588	1.8	1.911	-2.22	5.82
Reading speed	0.19	18	0.85	34.0	177.34	-338.5	406.59

VRG baseline							
Comprehension	0.128	18	0.899	1.00	7.810	-15.41	17.41
Words per minute	0.68	18	0.499	-3.00	4.354	-12.15	6.15
Errors	0.71	18	0.481	1.20	1.670	-2.31	4.71

Note. Raw score outcome measure results were used. t is the test statistic. df is the degrees of freedom. Sig (2 tailed) is the p-value corresponding to the given test statistic and degrees of freedom. Mean difference is the difference between the sample means. Std. error difference is the standard error. BPVS is the British Picture Vocabulary Scale. Burns and Roe is the Burns and Roe Informal Reading Inventory – 8th edition. RAN/RAS is the Rapid Automatized Naming and Rapid Alternating Stimulus Test. TOWRE is the Test of Word Reading Efficiency. WIAT-II is the Wechsler Individual Achievement Test – 2nd edition. VRG refers to the in-built assessment measures on the Virtual Reading Gym online programme. Noteworthy results have been highlighted.