An examination of the effectiveness of a digital tool as an intervention measure to improve the reading comprehension skills of high school learners

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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Abstract

The current level of literacy in South Africa is cause for concern. The Annual National Assessment of Literacy and Numeracy, conducted nationally by the National Department of Education of South Africa, shows that only 28% of Grade 3 learners and 35% of Grade 6 learners passed these tests in 2011 (Department of Basic Education (a), 2011). According to the policy on progression and promotion issued by the National Department of Education, learners may only be retained once in a phase, which means that these learners may lack essential academic literacy skills when they reach high school.

The main concern addressed in this thesis is whether high school teachers can help improve academic literacy by using reading comprehension software, like *Reading Rocket,* as an intervention tool to help learners who struggle with reading comprehension, and whether *Reading Rocket* is in fact an effective program to use for such purposes.

This study was conducted by using data from one school within the Western Cape which has been using *Reading Rocket* for the past three years. Use of the program forms part of their timetable, and Grade 8 and 9 learners spend twice per cycle working with the program. Learners are first tested on entering Grade 8 and group reports are retrieved from the program each term to monitor their progress. These reports give a summary of the reading level, the percentage gained in the reading exercises, reading speed in w.p.m and a spelling score in percentage. This data was used to compile a summary of the results obtained over six terms Term 1 2010 until Term 3 2011. These results were compared with quarterly classroom (paper-based) comprehension and language tests in order to determine is a correlation between the program data and the paper-based test data. There is no control group for this study as all the Grade 8 and 9 learners use the program.

There is no conclusive evidence that the program is an effective intervention tool, but findings show a positive correlation between program data and paper-based test data which indicates that the program may be used as a tool to determine on what grade level learners read.

Given the numerous responsibilities and duties of teachers, it is essential that they are given an effective measuring tool for literacy and because computer software is essentially objective and time-effective in provide results, using computer technology for such purposes may be part of a solution to improve literacy in South Africa.

O p s o m m i n g

Die huidige toestand van geletterdheid in Suid-Afrika is kommerwekkend. Resultate in 2011 van die jaarlikse nasionale assesseringstoetse vir geletterdheid en gesyferdheid wat nasionaal deur die Nasionale Onderwysdepartement gedoen word, wys dat net 28% van Graad 3-leerders en 35% van Graad 6-leerders hierdie toetse slaag (Department of Basic Education (a), 2011). Volgens die beleid van progressie en promosie van die Nasionale Onderwysdepartement mag leerders net eenkeer in ,n schoolfase agtergehou word wat beteken dat bogenoemde leerders dalk nie die geleentheid het om voldoende te verbeter voordat hulle die hoërskoolfases betree nie.

Die hoofkwessie wat in hierdie tesis aangespreek word is of hoërskoolonderwysers rekenaar sagteware soos *Reading Rocket* as ’n intervensie metode kan gebruik om leerders se akademiese leesbegrip te verbeter, en of *Reading Rocket* wel ’n effektiewe intervensiemiddel is.

’n Studie is gedoen deur die data van een skool in die Wes-Kaap te gebruik wat *Reading Rocket* al vir die afgelope drie jaar gebruik. Dit vorm deel van hulle skoolrooster en graad 8 en 9-leerders spandeer twee keer per siklus aan die program. Groepverslae wat deur die program opgedateer word elke kwartaal getrek om progressie te monitor. Die verslae bevat ’n opsomming van die leerders se leesvlak, leesbegrip in persentasie, leesspoed in w.p.m en ’n persentasie vir spelling. Hierdie data is gebruik om ‘n opsomming saam te stel van die resultate oor ses kwartale (kwartaal 1 2010 tot kwartaal 3 2011). Die programresultate is vergelyk met resultate van klaskamer (papiergebaseerde) begripstoetse en eksamens wat hulle vir dieselfde kwartale geskryf het. Omdat al die graad 8 en 9-leerders aan die program blootgestel word, is daar nie ’n kontrolegroep vir die studie nie.

Daar is nie konkrete bewys dat die program ’n effektiewe intervensiemiddel is nie, maar statistieke wys wel dat daar ’n positiewe korrelasie tussen die programdata en die papiergebasseerde data is en daarom word die gevolgtrekking gemaak dat die program wel as ’n instrument kan gebruik word om die leerders se leesbegrip op enige stadium van die jaar te toets.

Weens vele verantwoordelikhede is dit essensieel dat onderwysers ’n effektiewe metingsinstrument vir leesbegrip tot hulle beskikking het. Omdat rekenaarsagteware soos *Reading Rocket* tydbesparend en objektief in die voorsiening van resultate is, mag die gebruik van sulke tegnologie deel van ’n plan vorm om geletterdheidsvlakke in Suid-Afrika te verbeter.

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CHAPTER 1: Introduction

1.1 Rationale

Reading comprehension is essential for academic achievement. Daniel, Walsh, Adam, Goldstone and Arnold (2006: 508) state that learners "with poor reading and accompanying academic difficulties may experience increasing frustration, low self-esteem, and loss of motivation for learning as they progress through school". These negative effects are not only restricted to the school environment, but also effect learners' personal lives. It is thus imperative for all teachers to help learners improve their reading ability. The purpose of this study is to investigate whether teachers could improve learners' reading comprehension by using technology.

My research will focus on how technology can be used as an intervention measure in classes where learners struggle with mother tongue reading comprehension. In this study the mother tongue in question is Afrikaans. One specific digital reading program is evaluated in terms of its effectiveness as an intervention for reading comprehension problems. The program *Reading Rocket* is endorsed by Khanya (see section 4.1.2.1b) and familiar to learners of about 600 schools in South Africa. According to Engelbrecht (2011a) *Reading Rocket* has been used to improve reading comprehension since 1998. Because the program was developed in South Africa, the Afrikaans/English bilingual option makes it ideal for the South African environment in which it will be tested. The goal of this study is to see whether *Reading Rocket* is truly as effective as the developers claim it to be.

One of the reasons for choosing a high school is that high school teachers are not primarily trained as remedial teachers even though there seems to be a growing need for them to be able to give remedial support. The Postgraduate Certificate in Education course for prospective high school teachers at Stellenbosch University only offers one subject connected to learner support namely "Learning and Learner Support" (University of Stellenbosch, 2011: 80). "Learning and Learner Support" does not provide the pre-service teacher students with adequate practical experience in how to deal with learning barriers, but focuses mainly on the theory of the different barriers to learning and inclusive education in South African schools. Therefore, new teachers start their career with no practical experience in how to deal with the reality of learning and reading difficulties that await them in the classroom.

Another reason for choosing a high school is that learners are past the critical age of 14 years, the time in which language learning is considered to be almost effortless (Fromkin, Rodman, & Hyams, 2007). Thus, learners who attain only literacy levels 1 (0-29%) and 2 (30%-39%) struggle immensely without the above-mentioned remedial support. See Table 4 in section 1.3.4 for more information

on these levels of academic achievement. Personal experience has shown that these learners need special help in all areas of their schooling, but because of the lack of remedial teachers and the time constraints of mainstream teachers, they do not always receive the attention they need.

Furthermore, as most high school learners are already familiar with technology and computers, it is easier to test a computer program with them as users as this does not introduce an unintended variable which needs to be addressed. The effectiveness of the program will be evaluated in terms of its ability to improve reading comprehension. Most important would be to ascertain that the reading skills acquired from using the program are transferred to learners' academic reading. Because it is too difficult to monitor learners' recreational reading with certainty, the focus will be on their academic reading skills in the language classroom. On these grounds recommendations about the uses and possible improvements could be made to teachers.

1.2 Problem statement

"[O]nly 15% of all Grade 6 learners in South Africa [achieved] the required pass rate of 48% in literacy tests in 2008" (Le Cordeur, 2010: 78). These statistics are alarming if one takes into account that these learners are probably in Grade 9 in 2011. The guidelines for learner progression from one grade to the next, as provided in the policy on progression and promotion used in South African schools, may be a contributing factor for these low levels of literacy. This policy is explained in section 1.3.4.

"[T]he literacy and numeracy skills of the learners in the Western Cape are far below what is required for them to learn and develop effectively" (WCED (d), 2006). In order to monitor levels of literacy and numeracy, the National Education Department implemented the Annual National Assessments (ANAs) for literacy and numeracy and the WCED issued a document describing the long-term goals (2006-2016) and projections for their strategy to improve levels of literacy and numeracy in the province (WCED (d), 2006). Donald Grant, Western Cape Minister of Education, comments that, "The WCED has set bold targets to improve literacy and numeracy in the province by 2014" (WCED (a), 2010: 2). As a part of the ANA strategy Grade 3 and 6 learners are tested each year, alternating between grades. The tests, of which the results are used to determine the level of literacy and numeracy of the learners, are set and invigilated by people from the department and not by the teachers themselves.

The most recent ANA results were discussed in a report issued by the Department of Basic Education (Department of Basic Education (a), 2011). The scores are categorised according to levels, ranging from Level 1 to Level 4. Each of these levels denotes a score range given in percentage.

Table 1 ANA Score Chart: Percentage (%) per level

Level	***Description***	***Score range***
1	Not achieved	Score Less than 35%
2	Partially achieved	At least 35% but less than 50%
3	Achieved	At least 50% but less than 70%
4	Outstanding	At least 70%

Source: Department of Basic Education, 2011: 30

Results for 2011 were categorised according to province and grade and then according to each subdivision of the test. The 2011 Grade 3 mean percentage for literacy for the Western Cape is 43% and the Grade 6 Language percentage is 40%, which shows a decline of 3%. This places the average learner on Level 2 which means that literacy is only partially achieved by most learners. Below is a provincial overview of the mean scores.

Table 2 Provincial ANA scores

Province	Grade 3 mean % LITERACY	Grade 6 mean % LANGUAGE
EC	39	29
FS	37	23
GP	35	35
KZN	39	29
LIM	30	21
MPU	27	20
NC	28	27
NW	30	22
WC	43	40
NATIONAL	35	28

Source: Department of Basic Education(b), 2011

The report gives a national gender-based comparison for the respective levels. If these results are recalculated to give a non-gender overview, the results show that 69% of Grade 6 learners scored at

Level 1 which is below 35%. 14.5% learners scored in the Level 2 range and only 3.5% of all Grade 6 learners scored in the range of Level 4.

These results show that very few learners possess the skills to answer complex comprehension questions and that they are only able to answer question that refer directly to the text (Department of Basic Education (a), 2011). With scores as low as these, learners obviously do not possess the necessary reading skills to progress academically.

The current research question is whether a digital reading comprehension program like *Reading Rocket* can be used effectively to improve learners' literacy skills in context away from the computer, such as academic reading and recreational reading. The hypothesis is that *Reading Rocket* could be used as an intervention strategy so that learners will not only improve in using the program, but also read with more comprehension in other learning contexts.

1.3 Educational Context

The current research was conducted in an Afrikaans-speaking community in the Western Cape, not only for ease of access but also because the province is unique because the Western Cape Education Department (WCED) endorsed the Khanya project; which aims to provide schools with technological facilities, thus providing a solid basis from which to conduct research into the use of technology in the classroom.

1.3.1 Khanya

The WCED initiated the Khanya project in 2001 in an attempt to "determine the contribution that technology could make towards addressing the increasing shortage of educator capacity in schools" (Khanya, 2011). The project's coordinators present four main goals: 1) to alleviate the shortage of teachers, especially those in the areas of Mathematics and Science, 2) facilitating co-operation between the business sector and education sector in terms of supplying resources, 3) to equalise the availability of technology to all learners, and 4) to prepare the Western Cape for the 21st century and its technological demands. The primary goal is not to make learners computer literate, "but rather to use technology as a teaching aid, hence to improve curriculum delivery" (Khanya, 2011).

Currently there are about 133 Khanya schools in the West Coast area. Of these there are 11 combined schools (Grades 1-12) and 12 secondary schools (Grades 8-12). This area has 3 Khanya facilitators who provide maintenance and updating of the computer facilities in Khanya schools. In the Winelands area there are a total of 232 Khanya schools of which 11 are combined schools and 43

are secondary schools. These schools are in various phases of implementation of technological resources. There are 4 facilitators in this area. All of these schools are in the stage of curriculum delivery meaning that they use the Khanya facilities as part of their daily teaching.

1.3.2 Political influence

It is also important to put the current educational context into historical perspective. The 1994 elections and subsequent end of apartheid was a pivotal moment in the development and shaping of education within South Africa. According to Chisholm:

> The ANC introduced a reforming, pragmatic approach to curriculum reform. Teacher unions reasserted the importance of outcomes-based education as foundational philosophy, and established the necessity for a workable and implementable post-apartheid curriculum. They united around a secular, humanist, rights-based curriculum (2005: 79).

From this platform the South African Department of Education has issued a number of policies in an attempt to reform educational policy and practice. An overview of the approaches and their policies will be given in order to shed some light on the current educational situation, namely: Outcome-Based Education (OBE), the Progression and Promotion Policy and CAPS.

1.3.3 Educational policies

1.3.3.1 Outcome-Based Education (OBE)

OBE was implemented in various forms over the past decade. Its first implementation was in 1998 and later in 2005 as Curriculum 2005 (C2005). C2005 was followed by the National Curriculum Statement Grades R-12 (NCS). The NCS was replaced by the Revised National Curriculum Statement (RNCS) (Lombard & Grosser, 2008). The RNCS will be replaced by CAPS as of 2012. The evaluation of OBE as such is not the focus of this study, but it should be noted that OBE has both been praised, (Harden *et al.*, 1999; Brandt: 1992) as well as criticized, (Lombard & Grosser, 2008).

OBE is an educational approach that evaluates the success of the educational process by assessing the skills considered essential in the different learning areas, in other words “the outcomes the students should display by the end of the course” (Harden, Crosby, & Davis, 1999: 8). According to Lombard and Grosser (2008), OBE contains seven critical outcomes and five developmental outcomes. The Critical Outcomes entail how learners think about what they learn. They should be able to evaluate information, critically discuss it, analyze and synthesize and incorporate new information into what they already know. Developmental outcomes are those goals that are specific

to every learning area. These outcomes were incorporated into the Revised National Curriculum Statement (R-9). According to this document each learning area has different Learning Outcomes (LOs).

There are six LOs for Afrikaans Home Language as described in the RNCS and are as follows (WCED (b), 2002):

1) Listening,
2) Speaking,
3) Reading and Viewing,
4) Writing,
5) Thinking and Reasoning, and
6) Language Structure and Use.

For each of these LOs there are specific Assessment Standards (ASs) according to which teachers can monitor learners' progression. All these ASs are in some way important if one wants to read successfully, however, LO 3 (Reading and Viewing) encapsulates most effectively what is expected of a learner when reading a text. LO 3 focuses on Reading and Viewing, and states that the learner should be able to do the following:

> Die leerder is in staat om vir inligting en genot te lees en te kyk en krities op die estetiese, kulturele en emosionele waardes in tekste te reageer. Lees vorm die grondslag vir skryf en is 'n middel tot lewenslange leer. Leerders behoort 'n wye verskeidenheid fiksie en nie-fiksie te lees. Dit sal hul taalontwikkeling, algemene kennis en persoonlike groei bevorder. (WCED (b), 2002: 100)

The learners should, therefore, be able to think critically about what they read, not only for enjoyment, but also to evaluate the embedded cultural and emotional values of the text.

This LO, moreover, entails that the learner should be able to read a wide range of texts. Learners should be able to use any number of reading strategies in order to extract information from the text, be it for recreational or academic purposes. They should be able to summarize the main ideas of a text and be able to evaluate texts in terms of their structure and function and how it influences the way in which the central message comes across. These are only some of the Assessment Standards for LO3 which become more complex as the learner progresses from one grade to the next. Therefore, it is imperative that learners should be successful in the attainment of these ASs for each grade because if they do not, their understanding of texts will diminish as they progress to the higher grades.

It seems, if one looks at the literacy statistics for the Western Cape, that learners' grasp on reading comprehension is already weak and not improving. Learners' problematic literacy skills may be compounded by the way learners are promoted to higher grade levels at school.

1.3.3.2 Progression and Promotion

The South African school system is divided into four phases. Grades R to 3 form the Foundation Phase. The Intermediate Phase starts at Grade 4 and ends with Grade 6. The Senior Phase is Grades 7 to 9 and the Further Education and Training Phase starts with Grade 10 and ends with Grade 12. The policy on progression from one grade to another is influenced by these phases.

The *National Policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12* is a document that stipulates the policy on promotion. The following statement is made about the progression and promotion of learners from the Foundation Phase, but it applies to all subsequent phases:

> A learner who does not meet the requirements for promotion can be progressed to the next grade in order to prevent the learner being retained in the Foundation Phase for longer than five years (WCED (f), 2011: 10).

This means that learners have one year for each grade and may only be retained once in a phase. In order to pass, learners in the Foundation Phase and Intermediate Phase must have at least a Level 4 percentage for their Home Language and a Level 3 for an Additional Language. The table below shows the percentages for each level. The percentages vary greatly per level, but learners receive the same codes, and that in itself is a cause for concern: A learner with 50% is not on the same level as a learner with almost 70%, yet they receive the same code as can be seen below.

Table 3 Codes and descriptors for recording and reporting in Grade R-6

Rating Code	Descriptor	Percentage (%)
4	Outstanding/Excellent Achievement	70-100
3	Satisfactory Achievement	50-69
2	Partial Achievement	35-49
1	Not Achieved	1-34

Source: WCED (f), 2011: 11

In the Senior Phase and Further Education and Training Phase the minimum requirements are 40% for a Home Language and 30% for a First Additional Language. From 2012 these requirements will be increased with 10% each. The codes for Foundation Phase and Intermediate Phase will also be changed to the 7-level scale already in use in the Senior and FET Phases.

Table 4 Achievement codes (Grades 7-12)

RATING CODE	*DESCRIPTION OF COMPETENCE*	*PERCENTAGE*
7	Outstanding achievement	80 – 100
6	Meritorious achievement	70 – 79
5	Substantial achievement	60 – 69
4	Adequate achievement	50 – 59
3	Moderate achievement	40 – 49
2	Elementary achievement	30 – 39
1	Not achieved	0 – 29

Source: WCED (e), 2011: 137

With such low expectations and varying percentages learners are easily 'passed along' to the next grade without possessing the critical skills to master the work of that grade. This is part of the reason that high school teachers have learners in their classes who perform at a much lower grade level than could be reasonably accepted. A compounding factor in this situation is the lack of training in remedial teaching for high school teachers. Very few of them "necessarily know how to teach [learners] to decode" a language in the process of reading (Christie, 2008: 629), and given the ANA results it may be time that reading becomes a priority for teachers of all grades.

1.3.3.3 Curriculum and Assessment Policy Statement (CAPS)

CAPS is the most recently issued policy regarding the national curriculum. This year (2011) is focused on the introduction of CAPS and preparation of the teachers which is to be implemented in Grades R-3 and Grade 10 from January 2012. January 2013 is estimated to be the implementation year for Grades 4-6 and 11 and 2014 will introduce Grade 12 learners to CAPS (WCED (g), 2010). Even though it is not yet in use, it is worth mentioning this document in order to get a broader overview of educational development in South Africa. The document states that the effective use of language enables learners to acquire knowledge, to express their identity, feelings and ideas and to interact with others, and lastly to navigate the world around them (WCED (e), 2011: 11).

Home Language is allocated the most time of all subject areas in all the phases. Grade R starts with 10 hours per week; the Intermediate Phase 6 hours per week; the Senior Phase 5 hours per week and the FET phase 4.5 hours per week. The Additional Languages are allocated slightly less time, but

together language teaching accounts for between 9-13 teaching hours per week (WCED (e), 2011: 8-10).

The Learning Outcomes have been reduced to the four core skills of Listening and Speaking, Reading and Viewing, Writing and Presenting and Language Structure and Conventions. The document emphasises the importance of reading in cross-curricular activities (WCED (e), 2011: 11). The following table gives a more detailed account of the time allocation for Grades 7-9.

Table 5 Time allocation for Home Language (7-9)

<table>
<tr><th>Grades</th><th>Time allocation per week (hours)</th><th colspan="2">Time allocations over 2 weeks for skills to be acquired.</th></tr>
<tr><td rowspan="4">7-9</td><td rowspan="4">5</td><td colspan="2">Reading and Speaking: 2 hours</td></tr>
<tr><td rowspan="2">Reading: 4 hours</td><td>Reading comprehension: 2 hours</td></tr>
<tr><td>Prescribed literature: 2 hours</td></tr>
<tr><td>Writing and Presenting: 4 hours</td><td></td></tr>
</table>

Source: WCED (e), 2011: 19

According to this document there are three activities in the process of improving reading comprehension which is pre-reading, reading and post-reading. It describes the different strategies required for each of these three activities. It also describes how to improve vocabulary and learn language structures and finally how visual texts should be interpreted. The inclusion of information on reading activities and vocabulary is based on theoretical principles of language learning.

In the next chapter the neurological and cognitive complexities that make language learning and reading possible are discussed. Chapter 2 on the act of reading and Chapter 3 on Computer Assisted Language Learning (CALL) are separated as to give a more in-depth view of the numerous sources of literature on both topics.

CHAPTER 2: The Act of Reading

The act of reading is a complex interaction between neurological functions in the brain and cognitive processes of the mind. The number of reading and language learning theories in existence prove that reading is not a simple process of decoding a written language. The aim of this chapter is twofold. It is essential to understand the workings of both the brain and the mind so as to understand how reading theories are developed. Understanding the neurological, cognitive and theoretical aspects of reading enables one to determine whether software like *Reading Rocket* could be effective as an intervention tool for students who struggle with certain aspects of reading.

The chapter is divided according to the following aspects of reading: the neurological, the cognitive and the theoretical aspect. In the first section an overview is given on the nature of reading and the brain functions involved in the process. In the second section the underlying principles and skills of reading and the lower-level and higher-level cognitive processes involved are discussed, and also how working memory links these processes. Only a few of the many reading theories are discussed in the last section. Other factors that influence reading success, like attitude and context, are also briefly mentioned.

2.1 The Neurological Aspect

2.1.1 The Nature of Reading

The process of reading is considered by many authors to be one of the most complex processes that take place in the brain. Reading is a process of decoding a message in printed form that was originally encoded by an author in order to convey a specific message (Birr Moje & Sutherland, 2003; Fukkink, Hulstijn, & Simis, 2005; Nassaji: 2003).

The process of encoding refers to a person using the writing system of a language to write down his thoughts. The reader uses the same knowledge of that writing system to extract meaning from the text by decoding the written words. This is a very simple way of explaining the reading process, while the actual process of extraction of meaning and the brain functions that are used for this process of meaningful extraction are infinitely more complex than this give-and-take explanation deems it to be.

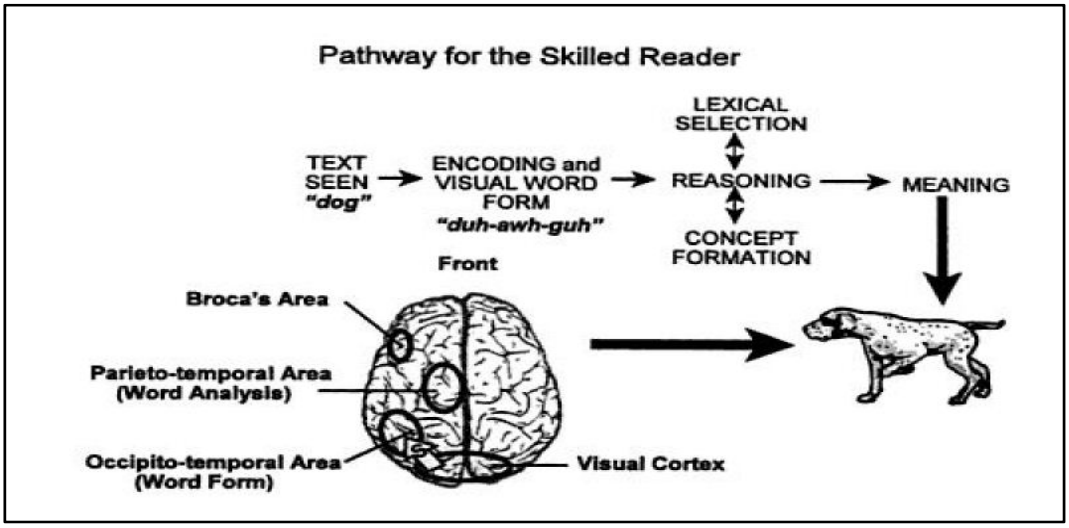
It has to be stated from the outset that reading is not a natural process, in contrast to spoken language development which is “a spontaneous maturational development typical of the human

species as a whole" (Akmajian, Demers, Farmer & Harnish, 2001: 505). There are specific areas in the brain that control spoken language (Broca's area and Wernicke's area), but there "are no areas of the brain that specialize in reading" (Sousa, 2001: 87). Wolf makes the statement that we "were never born to read" (in Grabe, 2009: 4). In contrast to the "genetically determined" (Akmajian *et al*, 2001: 505-506) ability to acquire a spoken language, reading has to be taught. In order to teach reading, one has to understand how the brain is used in the act of reading.

2.1.2 The Brain

It has already been said that there is no area in the brain that is specifically allocated for the purpose of reading. The brain combines the specialized skills of different areas when it needs to decode language in written form. "[S]uccessful reading involves the coordination of three neural networks: visual processing (orthography), sound recognition (phonology), and word interpretation (semantics)" (Sousa, 2001: 92). These neural networks are controlled by the visual cortex, the angular gyrus and the areas of Broca and Wernicke. Sousa (2001) explains the reading process as follows:

Image 1 Pathway for the Skilled Reader.



Source: Sousa, 2001: 92

The visual form of a word is the first aspect that is recognised by the brain. This form, for example, 'hond' is processed in the visual cortex. The word is then separated into its basic sound, phonemes by the angular gyrus. The reader is thus able to identify the pronunciation of 'hond' as /h□nt/. This process activates Broca's area so that the word can be identified according to what it sounds like in spoken language. Broca's area is responsible for making meaning of speech production. The brain's vocabulary store, reasoning and concept formation abilities are most likely located in the frontal cortex. Wernicke's area is responsible for storing the meaning of words. The activity from the

frontal cortex and Wernicke's area combine to activate the meaning of the word 'hond'. Once the meaning is processed a mental picture of a furry animal that barks is activated. When readers are struggling, the frontal cortex is more active because it is the area in the brain responsible for problem-solving. The process described here occurs in a fraction of a second.

The neurological aspect of reading comprehension is only the beginning, as much of the process of reading is contained in the cognitive processes that go with it. To truly understand the complexity of reading comprehension, it is necessary that one also has a sound understanding of the cognitive aspects of comprehension.

2.2 The Cognitive Aspect

The cognitive aspect of reading refers specifically to language and how it is put together. All languages are based on linguistic principles and readers need specific skills to decode language. The principles and skills of Afrikaans are discussed because it is the mother-tongue (L1) of the target group of this study.

2.2.1 Principles

The principles and skills of writing are the foundation of the reading process. One may argue that a Grade 8 learner should already have acquired these skills, but the ANA results presented in section 1.2 show that learners struggle with literacy in the primary grades where these principles and skills are supposed to have been mastered.

There are three basic components to all the words in a language: what they look like (orthography), what they sound like (phonology) and what they mean (semantics). Reading is the act of understanding a written representation of a spoken language. Therefore, it is important to make a few distinctions with regards to the difference between spoken language and written language.

In the first place, there is a difference between phonological and phonemic awareness. Phonological awareness, according to Sousa (2001) is the ability to break a verbal utterance down to its basic parts. A listener will be able to segment utterances into sentences, sentences into words, and words into phonemes. Phonemic awareness is the ability of a reader to link a letter (a symbol) with its corresponding sound. To do this successfully, the readers need to understand the alphabetic principle.

In the second place, the alphabetic principle is based on the understanding that spoken words can be represented in written form. Each word is made up of individual phonemes (sounds) represented by graphemes (letters) and these graphemes are combined according to language specific rules to correspond with the sounds of spoken language. These rules of grapheme combinations (spelling) are called orthography (Sousa, 2005).

There are five basic principles according to which phonemes can be combined (Paul, 2010). These principles are only the basis of orthography. Once learners know them they have to apply three basic skills in order to encode and decode written language (Paul, 2010). Table 5 (below) gives the principles and illustrates each with an example.

Table 6 Principles of Writing

Principles	Examples
Letters (graphemes) are pictures of sounds (phonemes)	Each letter of the alphabet has a corresponding phonetic sound. The letters can also be combined to form sound. See the principles below.
Some phonemes are made up of more than one grapheme.	S-n-eeu, m-oei-t-e, s-k-r-ee, lisensie
One phoneme may have various visual representations (graphemes/grapheme clusters)	The sound /f/ can be written as 'v' or 'f'. Voel, feetjie The /k/ sound can be written as 'dj', 'tj' or 'k' Hondjie, bietjie, kat The / i/ sound can be written as 'y' or 'ei' Ly, lei
One grapheme may have different phonemic representations.	The grapheme 'e' can sound like: Mekaar // Sekel /i /, / / lisensie /:/
Sometimes a grapheme has no corresponding phoneme.	Psigiater. The /p/ is silent.

2.2.2 Skills

There are three skills: blending, segmenting and sound manipulation (Paul, 2010). Blending is the ability to group together sounds in order for them to form a unit. Segmenting is the ability to separate sounds in words in the correct sequence. In other words, the reader is able to determine the sounds in words according to the letters that surround it. Sound manipulation is the ability to delete and add sounds in order to form new words. The process of combination and manipulation of language in the written form is more complex than the simple decoding of graphemes and decoding of words.

These more complex skills are what linguists refer to as lower-level and higher-level cognitive skills. The lower-level processes make use of the aforementioned principles to understand text as opposed to the higher-level skills which provide the awareness and ability to make sense of the message and deeper meaning of a text. Gambrell (2005) adds to this research by providing what she calls the four key cognitive skills in the reading process: memory, attention, processing rate (automaticity) and sequencing (rules of spelling). These skills are also mentioned as part of either the lower-level skills or the higher-level skills as described by Grabe (2009).

2.2.3 The Orthographic Depth Hypothesis

According to the Orthographic Depth hypothesis there are two types of orthography; shallow and deep. A shallow orthography means that there is more or less a 1:1 relationship between the phonemes and graphemes of a language. Afrikaans is a very good example of a shallow orthography as most words can be pronounced letter by letter.

In Afrikaans there are 17 vowel phonemes, 25 consonants and 8 diphthongs. (De Villiers & Ponelis, 1987: 1-4) Apart from the diphthongs like “eeu”, “eu”, and “ui” there are very few sound clusters in Afrikaans. The only consonant cluster is the “tj”, or “dj” in words like “bietjie” and “hondjie”. The “tj” is a /k/ sound and only occurs in the morpheme “-tjie”. There are very few silent letters in Afrikaans.

English on the other hand has a deep orthography. According to Sousa (2005) English has 44 phonemes and uses the 26 letters of the alphabet to represent these 44 phonemes in more or less 1,100 orthographic spellings. This means that a person cannot, like in Afrikaans, deduce the pronunciation of an English word just by looking at the way it is spelled.

The similarity between an L1 and L2 orthography can determine the speed and ease at which the latter is learned. In the multilingual South African context it is crucial that learners are able to read

very well in both their mother tongue (L1) and their additional languages (L2). For the current research the L1 refers to Afrikaans and the L2 refers to English because they are the languages spoken by the target group. Regardless of the depth of a language orthography, the principles on which Afrikaans and English are based remain the same. Thus, being able to read well in Afrikaans will help learners to read well in English, provided that teachers spend sufficient time on reading practice. An ESL learner's L2 word-recognition skills and the automaticity with which they are performed depend on the understanding he has of the L2 orthography and how it differs from his L1 orthography (Grabe, 2009).

2.2.4 Lower-level cognitive processes

"The brain's decision to retain learning seems to be based primarily on two criteria: *sense* and *meaning*" (Sousa, 2001: 14). Most researchers agree that deep, permanent comprehension cannot take place without the reader first understanding the text at text-level. Text-level is what Dorn and Soffos (2005) refer to as surface structure. Comprehension of this surface structure is based on a reader's capacity for word-recognition. A text is given to the reader and the reader has to read the words and understand them in order to extract an over-all meaning from the text. The lower-level cognitive skills that enable word-recognition are: orthographic, phonological, morphological, syntactic and semantic processes and lexical access.

2.2.4.1 Word-recognition

"Word recognition [is] the ability to read and identify words quickly and accurately" (Nassaji, 2003: 265). The act of recognising a word should not just be quick and accurate but automatic. Good readers recognise a word within 100 milliseconds and their focal vision is about 200 milliseconds. Being able to recognise a large vocabulary is a major indicator of reading ability (Grabe, 2009).

Grabe (2009) divides the word-recognition process into four steps. Step one is to recognise words rapidly and accurately. Fukkink, Hulstijn, & Simis (2005: 55) divide this recognition process into four areas: "(a) processes of sublexical letter recognition, (b) processes above the letter recognition level but below the word level, (c) processes at the lexical level within words, and (d) processes at the lexical level caused by a word's context". In other words a reader has to recognise each letter or meaningful letter combination and combine them into meaningful words. This corresponds with Grabe's second step which is to combine the graphic form of the word with the phonological information associated with its spoken counterpart. The third step, after the word has been identified phonologically and visually, is the activation of appropriate syntactic and semantic information of that word. Step four is to identify morphological affixes. These affixes determine

which lexical category and syntactic function it will fulfil, i.e. adjective, noun, verb or adverb. The following example illustrates the process for step four:

The word "verdedig" (defend) is a verb and is used to describe what someone does when they feel threatened. "Verdediging" on the other hand is a noun as indicated by the "-ing" suffix, and refers to an abstract concept. See the section on morphological processes below for a more complete explanation.

Being able to identify the affixes in words helps to access the lexicon. The mental lexicon is like a neural version of the Oxford dictionary. Every word known to the reader is stored in this dictionary (the lexicon) and each entry contains word meaning, syntactic information and all possible morphologically related words and also relevant contextual information. Identification of a word means that a reader is able to access all of the information associated with that word, understand it, and have the ability to use it in other contexts.

The steps described above do not occur in a linear fashion, but almost simultaneously. The five processes that enable successful execution of these steps are orthographic, phonological, morphological, semantic and syntactic, and lexical access.

a. Orthographic processes

Orthographic processes refer to the recognition of letters, letter groups and the physical lines and hoops that form the letter. These processes are influenced by the language which they represent. Letter combinations common to Afrikaans such as the diphthongs are more recognisable to people who are able to write the language. Afrikaans readers should automatically recognise letter combinations such as "-oei", "-lik", "-ee", "-eu" and "-tjie". Recurring letter groups such as these are chunked together in the mind in order facilitate the recognition process.

Just think of the way in which people remember cell phone numbers. The 082 is remembered as one chunk and instead of remembering 2-7-5-3-3-3-0 as separate numbers it may be chunked in the following way: twenty-seven- five – triple three- zero. In that way the number is reduced to fewer chunks and can be more easily remembered. Words work in the same way. Identifying word chunks such as grapheme clusters enables the reader to decode words faster using less cognitive energy.

Orthographic knowledge is very closely linked with the Alphabetic principle. "To be able to read, the brain must memorize a set of arbitrary squiggles (the alphabet) and indentify which symbols, called graphemes, correspond to the phonemes already stored in the mental lexicon" (Sousa, 2005: 35). This knowledge of the interaction between graphemes and phonemes is called graphophonic

knowledge (Nassaji, 2003). Orthography is the rules of spelling that govern the written system of a language, but phonology is the other half of the graphophonic knowledge as described by Nassaji.

b. Phonological processes

Phonological and orthographic processes are two halves of one whole. In order to understand this process one has to remember that all readers are able speakers. People can speak before they can read and learning to read is, in part, learning that spoken words have written counterparts. Referring back to the principles of writing it is a fact that a written language is not always a letter-for-letter translation of a spoken word. Sousa (2001) states that phonological awareness is the knowledge of how to combine phonemes into words. Phonological processes should help a reader to link the spoken words in the mental lexicon with the words seen in the text by using the rules of spelling for that specific language.

c. Morphological processes

Morphological processes work in parallel with lexical access and graphophonic knowledge. Morphology is the study of the smallest meaningful part of words and is needed to identify lexical items (words). These meaningful parts are called morphemes. "When readers understand morphemes, they can separate unfamiliar words into comprehensible parts. If the reader understands what [verdedig] means and also what [-ing] means, then the reader is likely to comprehend the meaning of [verdediging]" (Sousa, 2005: 40). A reader knows that the words "verdedig" and "verdediging" are related because of the common root "verdedig", but the reader knows that "verdedig" is a verb and that the morpheme "-ing" converts the verb into an noun. Morphemes help to determine the lexical category which in turn helps with its meaning. Morpheme changes also affect the syntactic position of a word as is illustrated by the underlined words below:

> Ek moes myself teen haar beskuldigings verdedig.
>
> My verdediging was nie suksesvol nie.

Like language-specific letter clusters there are language specific morphemes. That is one of the ways in which language is systematic. Afrikaans has certain specific affixes (prefixes and suffixes) that can be combined with root words to form new words or variations of root words. Thus, a reader should be able, by using morphological processes, to determine the meaning of unfamiliar words by breaking it into morphemes (Grabe, 2009) as is shown in the following example:

If a learner struggles to understand the word "intervokaliese" in the phrase "intervokaliese konsonante" he can use the textual context to determine the meaning or he could use morphological knowledge. The morphemes of "intervokaliese" are: /inter/ + /vokal/ + /ies/ + /e/. The root word is

"vokaal" which means vowel, the prefix "inter-" means between and the suffixes "-ies" and "-e" turns the word into an adjective which describes the position of a consonant. Thus, morphological knowledge helps the learner to understand that the phrase "intervokalsiese consonant" refers to a consonant that occurs between two vowels.

"Morphological awareness contributes to reading comprehension in the following ways: Meaning ... Syntactic properties ... Phonological properties ... Relational properties" (Sousa, 2005: 45). Apart from morpheme awareness and its relation to phonology there are rules that can be classified as morphosyntactic rules. These rules govern how morphemes determine the syntactic category of a word and thus alter its meaning.

d. Syntactic and Semantic processes

Knowledge of morphological rules supports the syntactic and semantic processes necessary to identify a word. "Syntactic awareness is the ability to understand the grammatical structure of a language" (Lipka & Siegel, 2007: 108). The grammatical structure of language, Afrikaans in this case, is determined by the rules according to which words can be combined within a sentence. Although semantic knowledge helps the reader to understand each individual word, the syntactic knowledge helps the reader to understand how the words are related to each other within a sentence. More often than not, syntactic structure determines the meaning of a sentence and not the semantic information connected to each word in a sentence. The way in which the meaning of words is determined by the syntactic context in which they occur is called syntactic parsing. Meaning on a syntactic level is drawn from tenses, word-order, articles and prepositions. All of these elements help to identify words (lexical items) and comprehend the overall meaning of a text.

For instance, Afrikaans speakers know that the verb is usually at the end of a sentence. This knowledge may help the learner to point out the verbs in a complex sentence with embedded clauses like the sentence below. All the verbs are underlined and at the end of their respective clauses.

> Leerders weet dat hulle eers die begripstoets moet deurlees voordat hulle die vrae beantwoord.

e. Lexical access

The level of lexical access is determined by the success by which each of the above mentioned processes are executed. The success of execution is in turn determined by the depth of linguistic knowledge of the reader. "Linguistic knowledge includes one's ability to (1) hear, distinguish, and categorize the sounds of speech (phonology), (2) understand the rules that constrain how words are

put together in phrases and sentences (syntax), and (3) understand the meaning of individual words and sentences and the relationships between them (semantics)" (Sousa, 2005: 92).

The ideal is that the reader should be able to identify all the words in a text by using his extensive linguistic knowledge and automatic processing skills. However, adolescent learners, such as the target group of this research, would not know all the words in a text and, therefore, need contextual clues to understand the meaning of unfamiliar words.

Contextual clues can be useful tools in understanding texts and when readers are not particularly skilled in one of the above-mentioned processes, context can play a vital role in the comprehension process. Context also helps with the disambiguation of homonyms and homophones. Contextual clues are, despite their advantages, not a foolproof method for comprehending texts, especially the complex expository texts which are used in high school classrooms.

Finally, Grabe (2009) emphasises that all the lower-level processes should be automatic so that more cognitive capacity is free to facilitate higher-level skills. This capacity is embodied in the working memory. The working memory is the link between the lower-level processes and the higher-level processes.

> Comprehension is a complex process regulated by cognitive, emotional, perceptual, and social experiences....The mind stores and processes information at two levels of comprehension: surface and deep. In any act of reading, these cognitive processes are controlled by our memory functions and our personal reading goals (Dorn & Soffos, 2005: 14).

Surface comprehension occurs at text level which is facilitated by the above-mentioned lower-level processes. Deep comprehension occurs when the lower-level processes are automatic. Extracting meaning from all levels is a complex dynamic process which needs sufficient memory. This memory needs to be active for the whole of the reading session and is called the working memory.

2.2.4.2 Working memory

"Working memory is the second temporary memory and the place where conscious, rather than subconscious, processing occurs" (Sousa, 2005: 47). It differs from long-term memory in terms of capacity. Long-term memory is a record of our experiences or, at least, the most significant ones and can go back several years. Working memory, in contrast, only has a capacity of 1-2 seconds (Grabe, 2009). According to Sousa (2005) there is also immediate memory that holds information for about 30 seconds until the reader can decide how to use the information. It is the working memory that is activated during any process, such as the reading process, that requires active concentration.

Working memory triggers long-term memory in the form of prior knowledge when a reader needs it to make sense of what is being read now.

Working memory is essential to reading because it enables the reader to process incoming information while remembering what has already been read (Lipka & Siegel, 2007; Kolonay & Kelly-Garris, 2009). Words are seen and identified by way of orthographical, phonological and semantic composition. Syntax helps to further give meaning to a word and, by combining all these composite parts, the mental lexicon is accessed and words, phrases and sentences can be understood. This is an ongoing process and requires a rapid process of elimination and active memory skills.

The process of elimination is facilitated by the ability of the reader to automatically go through these processes and this process is required of high school learners (Howerton & Thomas, 2004). Automaticity of any process means that it is performed at minimal expense of other cognitive processes.

The human mind has a limited capacity for paying conscious attention to more than one thing at the same time. Text comprehension is highly demanding and requires high amounts of cognitive control. If subtasks, such as word meaning retrieval, do not take place 'automatically,' they may therefore call for attentional capacity to the detriment of the higher-order comprehension task (Fukkink, Hulstijn, & Simis, 2005: 54).

This is why it is vital to develop learners' vocabulary and ability to recognise and understand words. If they are able to automatically recognise a vast vocabulary of lexical items, they have more cognitive capacity free to engage in higher-level processes.

2.2.5 Higher-level cognitive processes

The higher-level skills are not as well-defined in existing literature as the lower-level skills (Grabe, 2009). Researchers are, however, of the opinion that the successful use of higher-level skills directly correlates with the successful use of lower-level skills. This is because reading is a complex act of making links on text level as well as social level and thus requires an optimal amount of cognitive attention (Grabe, 2009). "[T]he amount of concentration used by dysfluent readers leaves an inadequate amount of attention for comprehension" (Howerton & Thomas, 2004: 79). Even though Howerton and Thomas focus their research on fluency, the principle of cognitive availability can be applied to other aspects of reading too.

Cognitive availability can be understood as the amount of attention that can be devoted to making meaning. If the lower-level processes are automatic and fluent, a reader should be able to use attentional processes to apply, support and maintain the necessary awareness to text.

Higher-level cognitive processes are controlled by the prefrontal cortex of the brain which is responsible for executive functioning such as "logic and reasoning, abstract thinking, problem solving [and] planning" (Lewis & Dahbany, 2008: 11). According to Grabe (2009) the higher-level processes can also be called attentional processes. These processes can be divided into four processes of comprehension awareness, metalinguistic awareness, metacognitive awareness and inferencing processes.

2.2.5.1 Comprehension awareness

This refers to the ability of readers to know whether comprehension is taking place or not. While reading a text every learner should be conscious of what he is reading and whether he understands it.

Gunderson describes two types of comprehension namely inferential comprehension and critical or evaluative comprehension (2006: 66). Inferential comprehension requires the reader to think about the writer's ideas and to understand the purposes of the text and the message of the writer. The reader should also be able to anticipate and predict outcomes (Gunderson, 2006). Evaluative comprehension requires the reader to judge the text in regards to validity, factual information versus opinion and the possibilities of applying what is read to other areas of life.

2.2.5.2 Metalinguistic awareness

Metalinguistic awareness means to be aware of the different components of language like phonology, morphology, syntax, how it affects the meaning-making process, and to be able to think critically about these processes. It is not automatically present even when lower-level skills are executed effectively (Grabe, 2009). The reader still has to use his knowledge of phonology, orthography and syntax to construct a coherent mental message from the text. An example of this would be how an article on "A day in Soweto" would have paragraphs that each contain information on the topic and should be linked together by the sequence of events that took place during this day.

2.2.5.3 Metacognitive awareness

Metacognitive awareness means that a reader is aware of his own thinking processes. He knows his strengths and weaknesses pertaining to reading and what is expected of him while reading. He also knows how to act when comprehension is somehow compromised.

The point of departure for any reading activity should include an awareness of the reading goals and comprehension strategies that are generally used by good readers. Before learners start a reading task it is essential that they are aware of the reasons/goals of the task. Summarizing an article on methods of saving electricity has different reading goals than reading a short story about a black-out. The first requires readers to extract the main ideas and list them and the second may be for enjoyment or answering questions set an the text. The 'why' of reading influences the 'how' of reading (Grabe, 2009).

An essential array of comprehension strategies is emphasised by a number of researchers which include the following: predicting, making inferences, using visual clues and visualising what is read, connecting, analyzing, summarizing, synthesizing, skimming, asking questions, and reflecting (Dorn & Soffos, 2005; Edmonds *et al.,* 2009; Routman & Butler, 1998; Sousa, 2001; Sousa, 2005). All these strategies are not needed for every reading activity, but learners should be taught how to identify which strategies are needed for which reading tasks and how to use them correctly.

2.2.5.4 Inferencing processes

Reading is never ever done in isolation. Readers generally want to connect what they are currently reading to what they have read or heard in the past. Some people are better at making these connections than others. Sometimes people make faulty connections, but the connections are made nonetheless. Prior knowledge is what allows people to make these connections when they read and the ability to make these connections is called inferential thinking. It is important to keep in mind that the successful implementation of prior knowledge can never take place without well-developed inferential thinking and that these two processes are in constant interaction.

Prior knowledge, or background knowledge, is the sum total of what a person already knows when reading a specific text. It is a combination of different kinds of knowledge; "general knowledge of the world, cultural knowledge, topical knowledge and specialist expertise knowledge" (Grabe, 2009: 74). Lui, Zhu & Nian make the following statement concerning prior knowledge: "One needs to connect new things with those known concepts, past experiences, or background knowledge, to understand new things" (2010: 61). It is essential that a reader not only has prior knowledge, but also the ability to access and use it to construct new knowledge and improve his understanding of the world. The Constructivist Theory, discussed in section 3.1.2.2, sheds more light on how prior knowledge is used to construct new knowledge.

Inferencing is the ability of a reader to connect what is read with prior knowledge. "[I]nferencing is one of the fundamental cognitive mechanisms that connect what we are currently attempting to

understand with memory resources that provide our background knowledge" (Grabe, 2009: 68). If the information is new, such as what is learnt in school, the learner should be able to use inferencing skills to understand what is read on text level and how it implicates his understanding of the world. In other words, inferential thinking gives the reader the ability to fill in the gaps and see connections between what is read and what is already known (Dorn & Soffos, 2005).

According to Mosenthal & Na (1980) there are several types of inferences. *Logical inferences* are used to understand a text at text-level, in other words, the inferences made while applying lower-level linguistic processes. *Enabling inferences* are used to organise the information gained from a text into a coherent whole. *Pragmatic inferencing*, the implicit word knowledge possessed by a reader, is not essential in the understanding the message of a text, but provides the proverbial depth or extra colour to what is read.

The ability to make inferences greatly varies from reader to reader. The more inferences a reader can make while reading a text, the greater his understanding would be (Dorn & Soffos, 2005). The number of inferences that can be made is directly equivalent to the depth of prior knowledge a reader possesses. It is vital that teachers understand what the effect of insufficient prior knowledge and inferencing is. Prior knowledge helps learners to make sense of new knowledge and inferencing helps them to make connections. Without prior knowledge the learners do not have a firm foundation from which to make inferences about what they read, which in turns makes academic performance extremely difficult. The act of reading is never just about the text, but how the text is interpreted by those who read it and how it affects their view of the world.

2.2.6 Other Factors that influence reading

2.2.6.1 Attitude

Attitude, self-image and interest are three of the most noticeable affective aspects of the reading process (Le Cordeur, 2010). Affect can be defined in "the context of language learning as aspects of emotion, feeling, mood or attitude which condition behaviour" (Mishan, 2005: 27).

The emotional side of the reading act is not as apparently important if one has only highly motivated learners in a class. These learners experience reading as something positive and therefore have no emotional blockages to impede learning. However, "struggling readers seldom have a positive attitude towards reading ... the cognitive (the intellect) as well as the affective (the emotions) is involved when one reads" (Le Cordeur, 2010: 85). It is when learners are resistant to the reading activity that it becomes difficult for teachers to motivate and help them to connect to what they are reading (Earman Stetter & Tejero Hughes, 2010).

Motivation and interest is what drive readers to read. It is an internal process that serves as an activation mechanism for reading as well as a guiding principle in the chosen material. Lenski describes motivation as affecting the willingness of students in terms of academic reading tasks (2008: 43). But it is not only about reading academic text. It also helps learners not to give up their reading activity mid-way, but to maintain a certain reading behaviour over extended periods (Lewis & Dahbany, 2008).

2.2.6.2 External Context

The term external context refers to any context in which the reading activity takes place that is not directly related to the text on text-level, such as social context, religious context, and academic context. For deep comprehension to take place four conditions should be met and they can only be met if the external context in which the reading activity takes place is favourably organised by the teacher:

1. The learner must have adequate prior knowledge,
2. The learner must have access to meaningful material and have enough motivation to sustain attention,
3. The learner must have enough time to process the reading material by way of rereading, clarifying and analysing and
4. There must be time enough for discussions with other learners in order to discover commonalities and differences in understanding and perceptions.

The *time allocation* of a reading activity should also be well-planned in advance. Especially when using technology, as will be discussed in the next chapter, teachers have to be precise in what they want learners to do and when they want them to do it. The availability of time is also influenced by the level of discipline that is exercised by the teacher and the learners alike. Without the necessary discipline, valuable time may be wasted.

Cultural neglect and *poverty* influence the amount of time available to reading activities as well as the motivation of the learners in the class. If a school is poor, it may not have the necessary resources, such as books, writing utensils and technology needed to facilitate learning and reading. In the first place, neglect refers to the position that reading fills in a community as some communities do not value reading as much as others. Some disadvantaged communities put a higher price on other skills, such as manual skills which more immediately translate into the ability to provide for the family. In the second place, neglect refers to the attitude of the teacher towards the teaching of

reading (Lenski, 2008). If the teacher assumes that reading is a natural ability she may not focus as much attention on teaching any of the aspects of reading as discussed in this chapter.

Lewis and Dahbany (2008) add another factor, namely, *learned helplessness*. This is mainly the result of all the other factors combined. If a learner has no motivation because of poverty or lack skills because of neglect, he may learn to blame his incapacity on these factors and cultivate a mindset in which he cannot learn no matter what the teacher does.

Finally, *resilience* is the opposite of learned helplessness. Resilience is the ability to draw on internal and external resources and strengths in times of adversity (Tatum & Fisher, 2008). These times of adversity may be of a personal nature or of an academic nature, both of which in some way have an influence on the way in which a learner perceives and engages in the reading task.

Resilience is cultivated and reinforced by either personal attributes already present in the learner or by the way in which the learning environment is structured. The latter is mostly determined by the way in which the teacher presents the reading material. The learners should possess certain social competencies, motivation and autonomy. If these attributes are lacking, the teacher should help learners develop them by providing a well-structured, goal-driven atmosphere in which the learners can be sure of what is expected of them and how to achieve the set goals.

The interactive complexity of any reading experience cannot be denied. Both teachers and learners should continuously strive to cultivate reading skills and a general love for reading. Being able to read well in the L1, enables learners to engage with the world around them. Having a firm understanding of the L1 becomes a resource for learning other languages. This is explained in the next section.

2.2.7 L1 reading as a resource

The ability to read may not be natural like speech, but the principles and underlying foundation of reading are nevertheless universal. When a child learns to read, the aforementioned processes are always present, in a greater or lesser extent. They also do not disappear or fall into disuse as the child ages. Thus, these processes can be, and are, applied to all languages. Being able to read well in the mother-tongue has a positive effect on learning to read in a second language. Universal aspects of reading are summarized in the list below (Grabe, 2009). While reading people,

- Carry out phonological processes,
- Use syntactic information to determine text meaning and text comprehension,

- Set goals, engage in reading strategies,
- Apply some level of metacognitive awareness to text comprehension,
- Engage capacity-limited working memory system,
- Draw on long-term memory to interpret what is read,
- Apply very rapid pattern recognition and automatic processing skills.

People use all available resources to make sense of the world around them and this applies to reading as well, however, the relationship between the L1 and L2 is not always benign. "L1 will obviously help with L2, or not" (Fitzgerald, 1995: 184). Not all learners are perfectly bilingual and some learners do not even have a firm grasp of their mother tongue. The reasons for the incomplete acquisition of a mother tongue are more than can be adequately discussed within the scope of this thesis, but suffice it to say that there are many learning problems that result from an insufficient knowledge of the L1.

Eisterhold Carson, Carrell, Kroll, & Kuehn (1990: 259) did a study on the effects of L1 education on L2 reading and writing skills. They had Chinese and Japanese ESL adult learners as participants and they found that "the higher the level of education either in L1 or L2, the better the reading scores". Even though the participants of my study differ considerably from those in the Chinese-Japanese study, the positive relationship between an L1 education and L2 reading skills remains valid.

"Being able to use the language(s) one has the best command of in any situation is an empowering factor and, conversely, not being able to do so is necessarily disempowering" (Alexander, 2009: 3). In the context of a multilingual South Africa, it is imperative that learners are fluent in more than one language. Being able to use an L1 with creativity and certainty opens up possibilities to do so in another language, and thus contributes to the academic and, later professional success of all readers.

The process of understanding these neurological and cognitive aspects has given rise to numerous languages learning theories and reading theories. In the next section an overview of the most prominent reading theories is given. Broader language learning theories will be discussed in Chapter 3 in conjunction with the discussion on CALL.

2.3 The Theoretical Aspect

All educational endeavours should have sound theoretical underpinnings in order to be successful. Theories reflect what researchers understand about a certain aspect of life at a specific point in time. As with other occurrences in society, psychologists, scientists and educators also put forth certain theories over time.

2.3.1 Theories of Reading

Four theories of reading will be discussed briefly namely the *bottom-up theory,* the *psycholinguistic theory,* the *schema theory* and *dual-coding theory.* Each of these theories has had a marked effect on the way that teachers approach the reading process. "[B]oth teachers and students hold a particular and identifiable theoretical orientation toward the process of reading and reading instruction, whether or not it is explicitly stated" (Zintz & Maggart, 1984: 7) and this orientation influences the manner of teaching and learning.

2.3.1.1 Bottom-up theory

The bottom-up theory postulates that the three basic language skills are the most important for reading comprehension. A learner should (1) blend letters to make sounds/words, (2) segment words to find the morphemes and sounds and (3) manipulate sounds/phonemes to make new words. (Paul, 2010) These are the basic skills that children first learn when they learn to read, but if these basic skills are not taught correctly, reading problems will follow the child into adolescence and adulthood. The bottom-up theory is a magnifying glass through which to look at these basic skills to see how they are applied in *Reading Rocket* and how they could be taught to adolescent learners.

The theory focuses on "graphophonics, syntax and semantics" (Fitzgerald, 1995: 150). The graphophonics are the sound-symbol relationship of words. The syntax is the grammatical structure of language and semantics is the meaning of words, phrases and sentences (Zintz & Maggart, 1984). This theory has also given rise to the phonics approach which focuses on "the mastery of sound-symbol correspondences" (Zintz & Maggart, 1984: 7). Supporters of this theory postulate that if learners can sound the letters and decode the words of a language they can understand what they read.

This theory, however useful it is, focuses mainly on text-level comprehension and does not give sufficient support for the higher-level cognitive processes that also take place. If reading was as simple as decoding the surface structure no person on earth would struggle with comprehension

after these decoding skills have been learned. A theory that considers these higher-level thinking skills to some extent is the schema theory.

2.3.1.2 Schema theory

Zintz and Maggart, (1984: 11) state that young learners of reading and writing already have "a fully developed language and possess all the skills of thinking, reasoning, problem solving, and imagining in oral language."

> Schema theory postulates that knowledge is systematically organized. A schema can be defined as having elements or components which can be delineated and which are ordered in specific ways. Readers are thought to use schemata to anticipate text content and structures, to guide understanding during reading, and to aid recall after reading (Fitzgerald, 1995: 150).

Schmidt states that these schemata "regulate the process of comprehension" (1982: 326). One would surmise that adolescent learners have a bank of existing knowledge (schemata) at their disposal when they read. These schemata and prior knowledge are, however, of little use when these learners struggle decoding written Afrikaans. That is why learners and teachers alike should have a sound linguistic knowledge of Afrikaans orthography and linguistics as described in the previous section on the bottom-up theory. I will look at the way in which *Reading Rocket* uses preparation exercises to activate prior knowledge for the purpose of improving learners' comprehension while reading texts.

Grabe (2009) has voiced some critique on the schema theory. According to him the schema theory operates on the assumption that prior knowledge and experiences can be definitely categorized. His critique on this assumption is that prior knowledge does not work according to a pattern and is thus not a stable structure that can be predicted. He also uses Carver (1992) to support this statement by saying that most reading comprehension does not require intensive inferencing and can be successfully operated on text-level alone. It is only in the case of difficult texts and when problem-solving skills are needed that schemata are activated. The psycholinguistic theory shows some improvement on the schemata theory in that it incorporates some features of the bottom-up theory.

2.3.1.3 The Psycholinguistic theory

This theory complements the bottom-up theory in that it takes the building blocks of language as described by the bottom-up theory and puts them into a specific context, thus also incorporating the schema theory. While learners read a text they use their background knowledge, or prior knowledge, of the world together with their knowledge of how language works in order to

comprehend what they read. While they read they make predictions based on their knowledge of the topic and linguistic knowledge of the language in which they read.

Fitzgerald states that "reading is not a linear process" (1995: 150). The non-linear, interactive quality of the reading process is further explained by what Gray calls the four steps in the reading act: perception, comprehension, reaction, and integration:

> Perception is the ability to pronounce the word as a meaningful unit. Comprehension is the ability to make individual words evoke useful ideas as they are read in context. Reaction requires judgmental action and a feeling about what the author has said. Integration, the final step, is the ability to assimilate the idea or concept into one's background of experience so that it is useful as a part of the total experience of the individual (in Zintz and Maggart, 1984: 14).

These four steps take place simultaneously, because learners have to recognise words and language while they derive meaning from the text and incorporate the information into their existing knowledge base. I will look at the way in which *Reading Rocket* blends linguistic knowledge of language such as syntax and semantics and social knowledge of language interaction to facilitate and build comprehension during the reading process.

Reading practice and teaching should not be a situation of *either* phonics *or* meaning, but rather an interaction between the two; the linguistic knowledge and prior knowledge. This interaction becomes more important when working with adolescents, because they already have background knowledge that could help with these processes. These processes can be facilitated by intelligent use of technology.

2.3.1.4 The Dual-Coding Theory

This theory was first put forth by Sadoski in 2004. In terms of existing theories, this is one of the more recent. According to Sadoski (Grabe, 2009) reading comprehension is the product of verbal and visual processes working together to derive meaning from texts. It accounts for the link between visual stimuli and reading comprehension.

The reader uses visual clues such as orthography, words, syntactic structures and other visual information to trigger visual representations that provide "conceptual mental representations of the information" (Grabe, 2009: 100). This means that the words, sentences and paragraphs act as pictures, each with their own lexical information to help the reader to construct a mental picture of what he reads. The verbal aspects of the reading activity are thus a growing network of activated concepts that help build the mental picture.

This is an improvement on the schema theory in that it does not work with abstract schemata, but only with what is given on the page (or screen). Thus, it also supports the notion that readers may not need the help of schemata but can rely on what is given to them on the page.

2.3.2 Models of Reading

When Grabe (2009: 83) states that "[m]odels characterize theories of reading" he implies that models of reading are practical manifestations of theoretical assumptions. Models, in contrast to theories, can be empirically more sound than theories because they can be researched more concretely.

Some models try to explain the relationship between the lower-level and higher-level skills while other models focus on one specific skill. Some models try to explain how a reader compensates when some of these lower-level and higher-level skills are lacking. For a more comprehensive list of the various reading models see Grabe (2009). I shall discuss only *The Two-Model, The Capacity Constraint Reader Model (CC Reader)* and two compensatory models because, for me, they illustrate how theory influences practice.

2.3.2.1 The Two-Model

The Two-model suggests that during the reading process a reader builds up a text model and a situation model from the information provided by the text. This model has at its roots some aspects of the bottom-up theory and some aspects of the psycholinguistic and dual-coding theory, as is explained below:

The reader uses the information provided at text-level such as the words, sentences, paragraphs and lay-out to generate an understanding of what the writer of the text wants to communicate to the reader. This process is driven by bridging inferences which link incoming textual data with data already activated in working memory. In this way each text can be understood as the writer intended it to be understood. Dorn and Soffos call this kind of comprehension "surface comprehension" (2005: 14) because it explains comprehension on a literal level.

What they term as "deep comprehension" (Dorn & Soffos, 2005: 14) is explained by Grabe's situation model. When a reader interacts with a text the interaction is never objective. The reader always brings his own understanding, attitude and background knowledge that helps him obtain more meaning from the text. The situation model explains how the reader brings meaning to a text to get meaning from a text and how this complex interaction makes the reading process a highly personal one (Goodman & Watson, 1998; Grabe, 2009; Dorn & Soffos, 2005 and Routman & Butler, 1998).

The situation model focuses on how the reader interacts mentally with the information gained from text-level. The reader uses the information gained on text-level to build up mental representations of what the text is communicating. According to Kintsch (1998) the situation model is built up of textual information, prior knowledge and specific domain knowledge.

The Two-model has a two-fold focus; the lower-level processes that help construct the text-model and the prior knowledge and inferences of the reader that build the situation model. The genre of the text has an effect on which model is predominantly used for the reading activity. For example, a poem does not have as much textual information as an academic article or a section in a biology handbook, but requires that a more elaborate situation model is built up from inferences and prior knowledge. The mental picture the reader builds up directly influences the information that he stores in long-term memory.

2.3.2.2 The Capacity Constraint Reader Model (CC Reader)

This model focuses on working memory and the effects that it may have on reading comprehension. According to the CC Reader Model there is still an interactive process between the lower-level and higher-level processes, but this interaction takes place within the constraints of working memory. According to the research done by Just & Carpenter "comprehension processes [are] dependent on input from lower-level processes and the processing capacity limits of working memory" (in Grabe, 2009: 95).

The capacity constraint of working memory refers to the ability of each individual reader to maintain optimal information activation while carrying out various linguistic, lower-level processes. The constraint may be influenced by the syntactic complexity of the text, the semantic ambiguity of the words, the length and density of textual information, the ability to filter useful from useless information and also external demands on memory such as time-constraint and, for instance, personal problems that influence concentration (Grabe, 2009).

2.3.2.3 Two Compensatory Models

The reading process, however often it may occur, is not always without obstacles. Even the most skilled readers sometimes come across obstacles while reading which requires some compensatory mechanism to help with the comprehension process. There are two models based on exactly such compensatory mechanisms namely the *Integrative Compensatory Model* and the *Compensatory-Encoding Model* (Grabe, 2009).

The Integrative Compensatory Model was put forward by Stanovich around the year 2000. He states that the lower-level processes should be automatic when conditions are optimal. If these processes are hampered in any way by means of visual, time or auditory constraints, the reader will use contextual information to facilitate the meaning-making process. This model tries to account for external factors that may impede fluent, automatic lower-level processes.

The *Compensatory-Encoding Model* is focused on the readers' internal processes. It states that readers are "continually using compensatory strategies to counter inefficiencies and specific skills weaknesses that affect all readers" (Grabe, 2009: 97). In the event of such shortcomings the learner will use metacognitive processes such as goal checking, monitoring and reading strategies. However these metacognitive strategies are only optimally present when there is no time constraint.

2.4 Application to *Reading Rocket*

The current curriculum of South Africa has "Reading and Viewing" as one of the LO's, and provides specific assessment standards for this outcome. See section 1.3.3.1. for more detail. Nevertheless, teachers have previously neglected teaching the intricacies of reading comprehension perhaps because they feel inadequate to teach skills that should be taught in the lower levels, or because other areas of the syllabus require more attention.

"After experiencing a long period of what Vacca and Alvermann (1998) described as 'benign neglect,' adolescent literacy is currently receiving much needed attention" (Harmon, Hedrick, Wood, & Vintenner, 2011: 105). Organisations such as the South African Teachers Union, (Suid-Afrikaanse Onderwysers Unie, SAOU) have taken this statement to heart and run workshops and information sessions for teachers on the topic of reading comprehension and learning difficulties. One such session was a symposium hosted by the SAOU on barriers to learning on 30 October 2010. The writing principles (section 2.2.1) and how to teach them for the improvement of reading were specifically discussed by Paul (2010).

Now that adolescent literacy has achieved 'spotlight status', attention needs to be focused on how resources like *Reading Rocket* can help to improve reading comprehension. Beatty (2010) states that the expectations of teachers, learners and programmers have to match to ensure the success of any computer program that is marketed as educational support. Therefore, developers of reading comprehension programs need to have a solid understanding of the educational theories of reading. They should know how the brain decodes written language and what processes are important in which situations. They need to understand which parts of the brain are involved in the act of reading

and what cognitive processes are used to understand text. They need to understand the evolution of theory in order to apply it to the social context into which the program will be introduced. Most importantly, they have to understand how teachers teach, how learners learn and what happens during a normal school day.

2.5 Conclusion

In way of describing the nature of reading this chapter gives an overview of what parts of the brain are used to decode the written language. It then illuminates how the orthography of a language is linked to the phonology of that language and explains how that the link is not always on a one-on-one basis. Thirdly this chapter describes the thinking processes required of a learner during the process of extracting meaning from the text. Lastly it gives an overview of some theories of language and reading. It is extremely important for teachers to be cognisant of these neurological, cognitive and theoretical aspects of reading and how they influence and are influenced by the socio-political and educational contexts in which people read.

As a preface to the next chapter, teachers need to be aware of how these aspects of reading can change over time. In current times technology is the heartbeat of almost every sphere of life. Nations communicate by e-mail, teenagers and grown-ups socialize through *Facebook* and novels are now digitally available for e-book readers like the Kindle and the iPad. All these domains require people to read, and to read well. Therefore, it is necessary to look at how knowledge from this chapter affects the development of educational software, especially reading software, and how teachers may effectively use technology to improve learners' reading comprehension.

CHAPTER 3: Reading comprehension and Technology

3.1 Understanding CALL

"Education in the twenty-first century must make a transition from the traditional education of assembly-line mentality, rote memorization, and antiquated thinking, to education that utilizes the cultural resources available to make education relevant to students and to the present-day world in which we live" (Johnson & Maxson McElroy, 2010: 9-10). In the context of this statement cultural resources refer to movies, video games, the Internet, and all sorts of technological and multimedia software and hardware available to teenagers today. All these sources may be used as a means to facilitate language learning and is known as CALL (Computer Assisted Language Learning).

Technology not only has a profound effect on the way teachers teach, but also on the way that learners learn. Both teachers and learners need new literacy skills to survive and thrive in the 21st century. Shetzer and Warschauer describe these skills as 'electronic literacy' (2000: 173) and Mishan (2005: 241) adds to this term the following explanation:

> [T]echnology has ... added a new repertoire of skills. These are known as 'electronic literacy' – the ability to find, select, organise and make use of information, as well as to read and write in the new medium.

A research imperative is to investigate what is considered to be 'good principles' when it comes to designing educational programs, because these programs may have a profound effect on how learners perceive the reading and learning process. Good principles refer to generally acceptable guidelines that, when applied, enhance the usability and success of a program. The way in which any educational computer program is marketed and presented affects the way in which it is used. Designers of educational programs need to be especially sensitive to how they structure the product in terms of goals, user-interface and aesthetic design. Fundamental to the success of such educational programmes are the sound theoretical principles on which they should be based. Appeal and accessibility should be secondary to theoretical principles derived from accepted language learning theory.

CALL has been afflicted by what Hanson-Smith calls the theoretical "hand-me-down syndrome" (2003: 21) which means that researchers and developers have been trying to qualify CALL according to other language learning and psycholinguistic theories relevant to other areas of research.

The developers of CALL were guided by the broader technological developments of a specific time. Therefore, CALL developed in phases according to what technology was available. Not only has CALL been subjected on a practical level to the technology of a specific period, but also on an abstract level to the prevalent learning theories of that time. Learning theories had a definite effect on the way the phases of CALL were classified and practised. Two major learning theories, namely, the Behaviourist theory and Constructivist theory will be discussed in order to illustrate how they correspond to the phases of CALL and how this influenced what happened in the language classroom.

3.1.1 Language Learning Theories

3.1.1.1 Behaviourist Theory

Behaviourism is a branch in psychology primarily focused on "people's behaviours, which are directly observable, rather than on the mental systems underlying these behaviours" (Fromkin *et al.*, 2007: 314). They considered language development to be a verbal behaviour entirely dependent on "environmental factors" (Meece & Daniels, 2008: 258). Psychologists in this field believe that people receive stimuli from their environment to which they give a certain response. If their response is the desired one, then that specific behaviour is positively reinforced. Mitchell & Myles call this kind of learning "the formation of habits". The following example shows how language and its use can be learned by constant repetition and conditioning through reinforcement.

> Applied to language learning, a certain situation will call for a certain response, for example meeting someone will call for some kind of greeting, and the response will be reinforced if the desired outcome is obtained, that is if the greeting is understood; in the case of communication breakdown, the particular response will not be reinforced and the learner will abandon it in favour of a response which will hopefully be successful, and therefore reinforced (Mitchell & Myles, 2002: 23).

A child is "endowed at birth with general learning abilities but not with any language-specific knowledge; linguistic behaviour is moulded (i.e., externally reinforced)" (Akmajian *et al.*, 2001: 478). According to behaviourists such as B.F Skinner, children imitate the speech they hear from each other and from adults. The speech environment is the determining factor in the process of language learning. Behaviourists imply that in order for people to learn how to speak they need to hear the words repetitively and need to be rewarded for correct speech and punished for incorrect speech.

It is true enough that in certain communication situations learners will change their behaviour according to the response they get from the people around them, but it is reductionist to say that something as complex and intuitive as language can be learned primarily by practicing endless

examples. Parents simply do not explicitly teach their children to speak and neither are they able to teach their children *all* the words of a language with enough repetitions for them to remember every word. Roger Brown, according to Fromkin *et al*. (2007), reported that parents very rarely negatively reinforced grammatically incorrect utterances, but rather rewarded or corrected the response on the basis of pronunciation and factual information.

It is this reductionist view of the behaviourist movement that received severe criticism during the 1950s in a debate on nature vs. nurture led by Noam Chomsky. Chomsky posited the theory of Universal Grammar (UG) in which he states that language has a biological basis, that there is a language acquisition device (LAD) in the brain enabling a child to acquire a fully functional grammatical language system without the explicit input implied by behaviourists (Akmajian *et al.,* 2001; Fromkin *et al.*, 2007)

Universal Grammar was a break-through in linguistic circles because it attempted to explain how small children can learn an entire language system within the first five years of life without explicit instruction. "The rules of UG provide the basic blueprint that all languages follow" (Fromkin *et al.,* 2007: 17-18), for instance, all languages have rules on how to form statements, questions and negatives. And all languages have rules on tense formation and the subject, object, verb sequence within sentences.

Chomsky also criticizes the behaviourist theory in that it ignores novel utterances (King, 2006). UG explains how people can create and produce sentences which they have never heard before and learn to use language correctly even when the input is "incomplete, noisy ... unstructured and ... impoverished" (Fromkin *et al.*, 2007: 320). UG does not deny the importance that environment plays in the acquisition of language, it only emphasises that it is not the only factor, nor even the determining factor, that determines successful language acquisition.

Behaviourist teaching entails that the teacher transmits knowledge to the ignorant student by way of repetitive exercises, the so-called 'tabula rasa' approach. In a language classroom this would most likely entail learning the rules of language by repetition and memorisation. Despite the critique from Chomsky, behaviourist methods of teaching are still popular, especially in the area of CALL. Computers do not tire from repetitive grading and feedback. The number of repetitions is also greater than can be handled by any teacher. Nevertheless, the primary flaw in this theory is that it ignores the creative cognitive processes that are so crucial for gaining mastery of a language.

3.1.1.2 Constructivist Theory

Constructivism tries to explain how people learn through constructing knowledge of the world through their own experiences. Jean Piaget suggested that learning takes place based on how learners interpret "the results of their interaction with the environment" (Pelech & Pieper, 2010: 12). Learners incorporate incoming information into existing mental knowledge structures. Lev Vygotsky expanded on this idea by adding social context. Therefore, the social situation within which a learner interprets and assimilates incoming 'data' with prior knowledge is as important as the assimilation process itself (Pelech & Pieper, 2010). Dewey supports both Piaget and Vygotsky in that he emphasises the process of making connections between new knowledge and prior knowledge. There are other constructivist theories by James, Rorty and Jensen which will not be mentioned in the current research, but serve to support Pelech's list of characteristics common to all the varieties of constructivist theory (2010: 8):

- People of all ages do not discover knowledge; rather, they construct it or make it.
- People create knowledge by relating or connecting it to their previous knowledge.
- Knowledge is an autonomous and subjective construction.
- Learning involves active restructuring of how one thinks.
- People use personal experiences and social interaction to create knowledge; thus, one's learning and ability to learn are influenced by previous experiences.
- Cognitive growth is stimulated when people are confronted with practical, contextual problems or personal problems that present situations that require a new way to think.

In contrast to the behaviourist theory, constructivist theory highlights the notion that teachers are not the transmitters of knowledge, but that they are facilitators and guides who allow learners to become more autonomous during the process of learning. Teachers have to allow learners to use their own unique way of incorporating any new knowledge. One way in which teachers facilitate learning is through asking questions. Bloom's Taxonomy of Questions give teachers clear guide for facilitating the learning process.

Bloom's Taxonomy of Questions is of particular value to the field of reading comprehension because it looks specifically at the different levels of comprehension and how different types of questions address these different levels of cognitive involvement. Comprehension questions can be classified in relation to the following six levels: 1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5)

Synthesis and 6) Evaluation (Beatty, 2010: 152-153). The taxonomy was revised in 2002 by David Krathwhol. See Table 7 for a comparison.

Factual knowledge, according to Krathwohl, refers to specific facts and terminology. Comprehension test questions that call for factual knowledge can be found directly from the text, i.e, "What happened when Red Riding Hood walked through the forest?" The answer "She met the wolf" can be found directly in the text. Such questions may start with instructions like "List", "Match" and "Name" (Pelech & Pieper, 2010: 65).

Conceptual knowledge questions on the Comprehension level require the learner to make more inferences about the information he reads in the text. He needs to explain certain statements and give examples. Summaries are good examples of how learners need to make inferences about what the main ideas of a text is. Comprehension questions usually start with "Cite", "Describe" and "Explain" (Pelech & Pieper, 2010).

According to the original Taxonomy the application, analysis, synthesis and evaluation particularly apply to how prior knowledge is used to answer a question from the text. The information is not explicitly stated in the text as is done for factual questions, rather the learner has to apply prior knowledge to what is asked and consolidate it with information from the text in order to get to an answer. Typically learners need to use these levels when discussing prescribed works. The teacher may ask learners to discuss "how does what happened to the character in the story relate to something in your own life?" (Pelech & Pieper, 2010: 67). Analysis questions require learners to compare, contrast and explain the event in terms of their own lives. Synthesis calls for hypotheses and predictions of future events based on what learners have read and know of the real world. Evaluation questions enable the learners to make judgements about what they have read and learned and also to make recommendations.

Bloom's Taxonomy is comprehensive in its organization of different types of knowledge and is therefore widely used by many teachers when they compile tests. For the purpose of software development, particularly for programs such as *Reading Rocket*, developers also need a sound understanding of how comprehension should be tested. The resources, especially the product, are thus the last group of factors that influence the success of CALL.

Apart from learning theories that influence the way in which CALL is conducted there are other factors that also influence the way in which people approach CALL. These factors can very roughly be divided into three groups; the human factor, the objectives and the resources. Within each of these

groups there can be many subdivisions, but for ease of discussion these three groups will have to suffice.

Table 7 An Overview of Bloom's Taxonomy

Structure of the Original Taxonomy	***Structure of the Knowledge Dimension of the Revised Taxonomy***	***Structure of the Cognitive Process Dimension of the Revised Taxonomy***
1.0 Knowledge 1.10 Knowledge of specifics 1.11 Knowledge of terminology 1.12 Knowledge of specific facts 1.20 Knowledge of ways and means of dealing with specifics 1.21 Knowledge of conventions 1.22 Knowledge of trends and sequences 1.23 Knowledge of classifications and categories 1.24 Knowledge of criteria 1.25 Knowledge of methodology 1.30 Knowledge of universals and abstractions in a field 1.31 Knowledge of principles and generalizations 1.32 Knowledge of theories and structures 2.0 Comprehension 2.1 Translation 2.2 Interpretation 2.3 Extrapolation	***A. Factual Knowledge***: The basic elements that students must know to be acquainted with a discipline or solve problems in it. Aa. Knowledge of terminology Ab. Knowledge of specific details and elements ***B. Conceptual Knowledge***: The interrelationships among the basic elements within a larger structure that enable them to function together. Ba. Knowledge of classifications and categories Bb. Knowledge of principles and generalizations Be. Knowledge of theories, models, and structures ***C. Procedural Knowledge***: How to do something methods of inquiry and criteria for using skills algorithms, techniques and methods. Ca. Knowledge of subject-specific skills and algorithms	***1.0 Remember***: Retrieving relevant knowledge from long-term memory. 1.1 Recognizing 1.2 Recalling ***2.0 Understand***: Determining the meaning of instructional messages, including oral, written, and graphic communication. 2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining ***3.0 Apply***: Carrying out or using a procedure in a given situation. 3.1 Executing 3.2 Implementing ***4.0 Analyze***: Breaking material into its constituent parts and detecting how the parts relate to one another and to an

3.0 Application 4.0 Analysis 4.1 Analysis of elements 4.2 Analysis of relationships 4.3 Analysis of organizational principles 5.0 Synthesis 5.1 Production of a unique communication 5.2 Production of a plan, or proposed set of operations 5.3 Derivation of a set of abstract relations 6.0 Evaluation 6.1 Evaluation in terms of internal evidence 6.2 Judgments in terms of external criteria each simpler category was prerequisite to master	Cb. Knowledge of subject-specific techniques and methods Cc. Knowledge of criteria for determining when to use appropriate procedures D. Metacognitive Knowledge-Knowledge of cognition in general as well as awareness and knowledge of one's own cognition. Da. Strategic knowledge Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge Dc. Self-knowledge	overall structure or purpose. 4.1 Differentiating 4.2 Organizing 4.3 Attributing ***5.0 Evaluate***: Making judgments based on criteria and standards. 5.1 Checking 5.2 Critiquing ***6.0 Create***: Putting elements together to form a novel, coherent whole or make an original product. 6.1 Generating 6.2 Planning 6.3 Producing

Source: Krathwohl, 2002: 214-215

3.1.2 The Timeline of CALL

I use the word timeline deliberately instead of background as CALL changes in conjunction with the evolving nature of technological advancements. Nevertheless, CALL does have distinct eras in which certain elements were prominent, but these eras are like the colours of the rainbow that shade into each other. Warschauer (1996) pinpointed certain 'phases of CALL', however, these phases were criticized by Bax (2003) for being incomplete and ambiguous. Both researchers have merit and together they give a complete picture of the development of CALL.

3.1.2.1 Technological developments

Beatty (2010) describes the advancement of technology according to three eras. These eras go hand in hand with developments in software and other technological tools, as well as theories of language learning. This is called the techno-theoretical relationship. The capabilities of technology in many ways determine how it can be used in a classroom. Hanson-Smith (2003) illuminates some of these developments as follows:

During the 1950s computer programs were strictly linear. They followed the input-output system so characteristic of Behaviourism. Mainframe computers were only available at universities where these mainframes offered content courses. Students had to master a topic a section at a time through drill-and-practice. The normal high school classroom was still following the chalk-and-talk method.

The 1970-1980s saw the evolution of the mainframe computer to that of the mini- and micro-computer. The micro-computer is the equivalent of the personal computer of today. This period also saw the birth of Videodisc and Floppy disk technology which enabled a wider distribution of computer software. Teachers had more freedom in terms of the material they could use and in so doing go beyond behaviouristic models of teaching.

The period between 1980 and 1990 was mostly "spent in trying to keep up with technological change" (Hanson-Smith, 2003: 21). According to her, mainframe computers were task-masters and the newest technology of that time was the PLATO system. The silicon chip was a mid-80's revolution and a 5-1/4 inch diskette ran on 64K of memory. Multimedia also became more prevalent towards the end of the 1990s (Beatty, 2010; Hanson-Smith, 2003).

Today, in the 21st century, there are cell phones that are able to perform functions of a desktop computer. Hard drive capacity is measured in terabytes instead of megabytes. "Google it" has become the default answer to almost all questions that people may have. All computers have audio-visual/video functions. E-mail and Skype have become as ordinary as a telephone call. Facebook, MySpace, YouTube and Wikipedia are for most people the normal way to share knowledge globally as well as locally.

It is evident that technology changes at an almost exponential rate, and is likely to continue to do so for some time to come. The question is no longer whether to use technology in teaching, but how to do so effectively (Hartman, Morsink, & Zheng, 2010). Because of the inevitability of technology in the classroom, it is absolutely vital to have an understanding of the theoretical underpinnings that have helped to construct CALL into what it is today. The phases of CALL, discussed in the next section

illustrate how technological development and learning theories are used together in the CALL classroom.

3.1.2.2 Phases and Approaches of CALL

The theoretical foundation of CALL lies in the work of Bax (2003) and Warschauer (1996). Warschauer divided CALL theory into three phases namely Structural CALL, Communicative CALL and Integrative CALL. Bax published his critique on these phases in 2003 in which he renamed the phases Restricted CALL, Open CALL and Integrated CALL. He also states that these are approaches and not actually phases, since all three approaches are still active today.

The *Structural Phase/Restricted CALL approach* was dominant roughly from 1960 until 1970 and perhaps into the 1980s. The phase was characterised by the repetitive drill-and-practice exercises so typical of the Behaviourist theory. These exercises are founded on the principle that language needs to be taught through repetition and that the stimulus-and-response method is most likely to be successful. Like the Behaviourist learning theory suggests, the teacher's role was that of monitor and provider of the correct answer. The learners were seen as ignorant, with nothing of their own knowledge to offer to the lesson. Much as behaviourism was an influential theory in educational circles, the range of technology that was on offer also played a part in what teachers could do in class.

For this reason Bax renamed the phase to *Restricted CALL*, because it was so repetitive and because the technology of that time did not allow for much else than "drill and kill exercises" (Warschauer, 1996: 3). In those years there was very little scope in what a computer could do, which meant that teachers had to harness what they could and make the best of it.

The second phase/approach was *Communicative CALL/Open CALL* (1980-1990). This is the phase in which the personal computer entered the classroom and for Warschauer this phase was the dawn of the more authentic approach to language learning. Constructivism played a role in teaching as teachers, instead of focusing on the forms of language like the grammar-drills, focused on using the forms in communicative contexts (Warschauer, 1996). In other words teachers taught grammar not by explicitly teaching the rules through repetitive exercises, but by using these forms in communication\ (Underwood in Warschauer, 1996). As the Constructivists stated, learners build knowledge through interaction and communication. Language is learned through using it in authentic situations. The learners become the active agents in the learning process and the teacher, as the constructivists suggest, becomes a facilitator and guide to the process of learning. For this phase the technology also had a broader scope on offer.

Bax states that the *Open CALL approach* refers as much to technological development as it does to the attitudes of teachers towards technology: "attitudes to using computers were more open … and were certainly becoming more humanistic" (Bax, 2003: 9). This Open Approach reflected the attitudes of teachers from the beginning of the 21st century. Bax was concerned about the attitudes of teachers not being as open as technology allowed them to be. It should be noted that teachers have become more open to the use of technology, but perhaps not yet fully accepting what technology can do in terms of advancing learning opportunities for teachers and learners alike.

The future of CALL, called the *Integrative Phase/Integrated Approach,* for both Warschauer and Bax, will be when CALL has fully integrated and normalised (Warschauer, 1996; Bax, 2003). This means that CALL will become as normal as using a pen and book. Some teachers are still becoming accustomed to what technology can do and some still have their doubts as to whether they will be able to use it effectively. Warshauer describes this Integrative phase as being dependent on how teachers use multimedia and the Internet. For him, hypermedia, the way in which different types of media are all linked together, is a powerful tool in the hands of teachers, but they still need to learn how to use it optimally.

On this topic of optimal use, Bax makes a valid point in saying that "CALL will be normalised when computers are treated as always secondary to learning itself, what the needs of learners will be carefully analysed first of all, and then the computer used to serve those needs" (2003: 10). Currently multimedia applications and the Internet are still seen as somewhat of a novelty and as such teachers focus too much on the adornments of technology rather than on its educational value. In order to get a clearer understanding of exactly how CALL can be used productively in the educational sphere is essential to remember that technology can never be successful on its own. There are always factors which influence the use of technology. These factors are discussed in section 3.1.3 below. Technology in whatever form or context is never used in isolation as there are always factors that influence its use. Kern made the statement that it is very seldom that technology itself is ineffective, but rather the way in which it is used (Kern, 2006). By saying that it is not technology that is ineffective, but the way in which it is used, Kern highlights the importance of human involvement in technology.

3.1.3 Factors that influence the use of technology

3.1.3.1 The Human factor

People sometimes have the tendency to think of technology as an autonomous, almost living, being when in actual fact the successful use thereof is more often than not dependent on the people who use it. People have the ability to use technology in just as unique a way as any other resource, and like most endeavours involving people, there are a multitude of different outcomes.

Beatty (2010) uses a model designed by Dunkin and Biddle (1974) to explain how the teacher and learners may be considered influencing factors. These include "Teacher and Learner formative experiences, Teacher training experiences and Learner exposure to technology and Teaching skills or Learning styles" (Beatty, 2010: 147).

Formative experiences refers to the experiences acquired by the teacher and learners based on age and socio-economic circumstances. It is important to take age into account as this could affect the way in which teachers and learners relate to technology and technological development. The main difference between teachers and learners, on the grounds of socio-economical status, is that learners are solely dependent on the material means of their parents in terms of the technology they can acquire. Learners have access only to the technology their parents can afford; teachers have a salary with which to buy the technology they want which means that exposure could be significantly different.

"Children from higher socioeconomic backgrounds use a broader range of computer applications than lower-income children" (Meece & Daniels, 2008: 244). These differences in exposure can have a profound effect on the way in which learners respond to a lesson, regardless of the technology-saturated culture in which they grow up. For example, if a teacher chooses to use a high resolution, high-tech interactive computer game as the basis for a lesson, learners with no experience of such games may be confounded with the novelty thereof and miss out on the underlying educational objective.

Teacher skills refer to the more psychological aspects of a teacher: "motives, abilities and attitudes" (Beatty, 2010: 148). Like every learner, each teacher is also unique. No two teachers teach the same lesson in exactly the same way. Some teachers, albeit because of training or upbringing or genetics are more 'tech-savvy' than others. It is important that teachers are aware of their abilities (or lack of them) and take responsibility for developing them.

Since learners have only the academic training from the school curriculum it is necessary to look at their *previous exposure to technology*. A child from the 21st century, no matter his or her age, is exponentially more exposed to technology than adults of the 21st century had been at the same age. Children grow up with technology while many adults have to make a conscious effort to understand and use new technologies. It is therefore not a leap of imagination in presuming that learners of today have in some way a greater intuitive approach to various forms of technology than adults do and that, therefore, technology would not be a barrier to learning.

Since "school provides the greatest access to computers" (Meece & Daniels, 2008: 244), it is imperative that the teacher optimises every opportunity of using technology. For that reason, *teacher training experiences* refer more specifically to the academic training received by a teacher. These do not only refer to the pre-service teacher training, but also to any courses taken while in service. The most important effect that these training experiences may have is that of affecting the attitude of the teacher towards using technology in the classroom.

Learning styles refer to the learners' preferred methods of studying and receiving information. Some learners are more receptive to listening and visual stimuli and some learners function really well independently, but not in group settings. These unique learning styles are not set in stone. Other learning styles can be developed, so teachers are not expected to cater for each unique style, as this is neither possible nor practical.

Learning styles and teacher skills, nevertheless, have to be kept in mind when planning a lesson. The teacher has to find a way in which to incorporate technology into lessons in such a way that does not undermine the nature of the teacher or the learner. That is why the objectives of lessons are so fundamental to the success of the lesson.

3.1.3.2 The Objectives

Objectives not only refer to the end results of a particular exercise, but also include the in-between objectives. They refer to both that of the teacher and of the learners. It is very easy to focus too much on the objectives of the teacher; what it is that needs to be taught, and how, that one tends to forget that learners, too, approach each lesson or task with a set of objectives of their own. For example, the teacher may use a Web-browsing activity as a collaboration opportunity for learners, but they may lose sight of this goal and see it as a less academic socializing activity. Matching teacher and learner objectives thus becomes an integral part of lesson planning and execution (Beatty, 2010).

The workings of a GPS may be useful as an analogy to clarify this statement. The objectives of a lesson are like the end destination and the structure of the lesson is like the route from point A to B. Teachers and learners both start with "Where am I now" and the goal is like asking "Where would I like to go". The in-between objectives are like the way-points along the way. No lesson has only a starting point and a finishing point. There are always some secondary objectives that need to be reached that serve as stepping stones to the end objective. However, learners and teachers may have similar goals and the necessary experience in using technology for certain learning situations, but they are futile without the necessary resources at hand. The resources discussed in the next section not only refer to technological resources but also to the human resources found within each society.

3.1.3.3 The Resources

The resources that function as variables for CALL are both on a micro and macro level, in other words, they are both part of the contexts they are used as well as product specific. If a teacher uses a specific product like *Reading Rocket* there are some other technological tools that need to be in place before the product can be used optimally and effectively.

The technological facilities of any given school have a profound effect on the way in which teachers can present lessons. These facilities are not just computer-related. They include smart boards, data projectors and other audio-visual equipment. Computer networks are almost indispensable to the successful use of CALL. To obtain such facilities, a school should have the support of the community in terms of donations or appeal to the National Department of Education for funds.

A more complex point to mention is the interaction of the resources to which learners and teachers are exposed within the school and within the home. Researchers are in agreement when they suggest that there is still "incomplete integration of computer technology and education" (Bax in Kern, 2006). This incomplete integration is, in part, a result of the mismatch between in-school and outside-school technology available to learners. An example of this would be the abundant use of social networking sites such as Facebook, MySpace and Twitter. Away from school, learners spend considerable time communicating with others via these networks, but they have not yet been realised as useful tools for teaching reading comprehension (Beatty, 2010).

The last member of the group of Resource factors is that of the program itself. The focus of the *Reading Rocket* software is to improve reading comprehension. The degree to which a program is user-friendly determines to a great extent how effective it will be in reaching the goals set by teachers, learners and developers alike. The program interface; the navigation and structure of the

program content allow it to be only used by one learner at a time, therefore, making collaborative learning difficult. For a clearer explanation of how software can influence the use of CALL, *Reading Rocket* is discussed in the next chapter.

3.2 Transferability of skills

A question that many researchers are asking is whether people use the same set of literacy skills for reading on screen and reading print. Literacy, as defined by Meece and Daniels is "the ability to construct and express meaning through reading, writing, and discussing texts" (2008: 254). They posit that these skills do not only apply to printed text, but go beyond printed text by constructing meaning, "in any of the [systems] used in the culture to create and convey meaning" (Eisner, in Meece & Daniels, 2008: 254).

In Beatty (2010) Warschauer suggests that a change in CALL user skills does not necessarily mean a change in other literacy skills. Online work does not necessarily provide the skills necessary for comprehension in other areas. A study done by Chen found that,

> students preferred to read *printed* materials rather than *online* information for leisure and entertainment, possibly because they had not been taught how to transfer their reading strategies from print texts to hypertexts, which influenced their online reading comprehension (2009: 111).

Learners need to be taught how to interact with online texts. Even though *Reading Rocket* is not a hypertextual program, there are still crucial differences between reading on screen and on paper. Hartman *et al.* state that reading on a screen may seem similar to paper-based reading, but there is a difference in the cognitive processes that are involved in both situations:

> Online comprehension is more complicated. It places many more processing demands on a reader. To be sure, many lower-level reading processes look much the same as readers shift from print to pixels. Decoding, word recognition, and comprehension of isolated sentences look very similar whether reading on- or offline. But the similarities are fewer with higher-level processes (Beatty, 2010: 131).

This statement specifically refers to the more complex inferencing skills and demands on working-memory needed to navigate the online environment. Hypertext is non-linear and vastly more intertextual than print text; therefore, a reader needs more finely developed higher skills, as discussed in section 2.2.5, to interpret online text.

Reading Rocket is done on screen, but it is specifically developed to improve both online reading and paper-based reading whether it be for academic of recreational purposes. *Reading Rocket* has built-

in functions for recording results for each exercise. The developers of the program use these result statistics to promote the program, but the question that is never raised is whether these results are transferable to areas away from the computer room. Do learners improve in the use of the program alone or is there a corresponding improvement in their results for standard paper-based reading comprehension tests? One may ask why successful transfer of skills is so important. O' Brien and Dubbels attempt to answer this:

> Those of us who, as literacy educators, have spent our careers studying how young people interact with printed texts are now faced with a new landscape that renders many of our theoretical models, instructional frameworks, and 'best' practices based on these print models inadequate or even obsolete. *Print text remains important but, as noted, expression is increasingly multimodal* (2008: 475-476). [Italics added]

Print reading has become one of many reading media. It is vital that learners are able to transfer general comprehension skills to each medium that requires it. Sorrell, Bell and McCallum further emphasises this point by saying that:

> [T]echnologically advanced hardware/software may not be empirically supported. Even though schools cannot avoid the technological revolution, educators must become aware of which computer programs are supported through research as being both instructionally efficient and effective. While teaching practices will likely focus on technological innovations, further evaluation is needed in order to determine *its efficacy as a component of skill* and curriculum delivery and to determine under which conditions certain hardware/software should be beneficial (Sorrell *et al.,* 2007: 11). [Italics added]

The main reason for researching the effectiveness of a specific computer program is to determine whether the skills acquired from using the program actually improve learners' literacy skills in areas away from the computer such as academic reading and recreational reading.

3.3 Application to *Reading Rocket*

Reading Rocket is one computer program of many available on the market from which educators and parents can choose. For the purposes of researching the effectiveness of such programs, *Reading Rocket* was the most accessible in terms of travelling arrangements and contact with schools that use the program. It has been stated in the previous chapter that expectations from different parties in education have to match before a program can be truly considered as successful.

"[C]hildren have become saturated with technology … The way that we teach these tech-savvy children must mirror the time in which they live" (Lacina, 2008: 363). Developers do user-testing on the basis of aesthetic appeal, but many of them do not do teacher-testing to find out whether their program will be successful as a teaching tool.

This chapter gives an overview of the development of CALL and how it is founded in Language Learning theory. In order to decide whether *Reading Rocket* is a theoretically sound program one has to keep in mind the phases of CALL as well as the cognitive processes discussed in the previous chapter. Is *Reading Rocket* a program that facilitates constructionist learning, behaviouristic learning or a little of both? Does the program fit in with current technological advancements? These are some of the questions that need to be answered.

CHAPTER 4: READING ROCKET

4.1 The Program: Reading Rocket

Reading Rocket has been functional since 1998. Ever since its introduction into the school system, the developers of the program have been striving to expose as many learners as possible to what they term a comprehensive computer program designed specifically for the classroom set-up. Currently schools have a choice to sign up for *Reading Rocket* as part of the Khanya project supported by the WCED or in a commercial capacity supported directly by the *Reading Rocket* developers. For each of these options schools have to obtain a software licence from the developers in order to use the program.

4.1.1 Getting started

4.1.1.1 Log-in

The program starts with a main index page on which learners click on "Reading Rocket" to access the log-in page. Each learner has a unique log-in name. If they are first-time users, the program redirects to a registration page. An image of the settings can be seen below.

Figure 1 Main Index Page

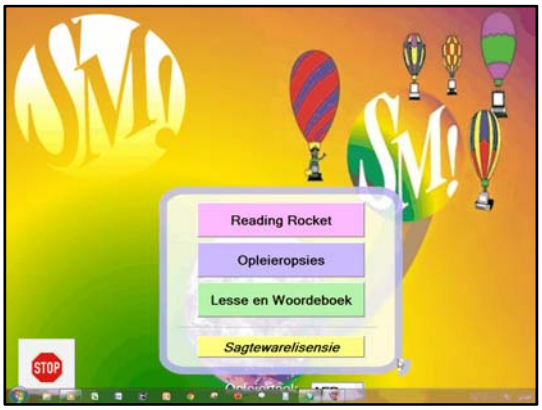
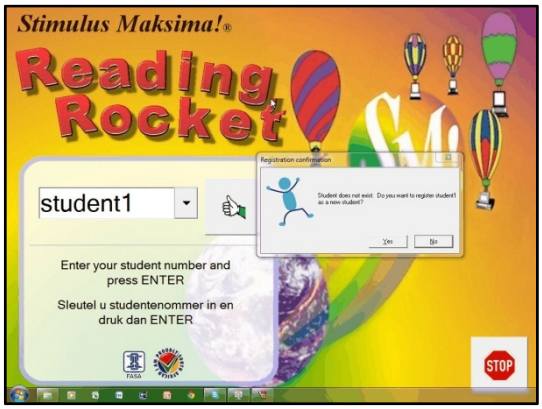
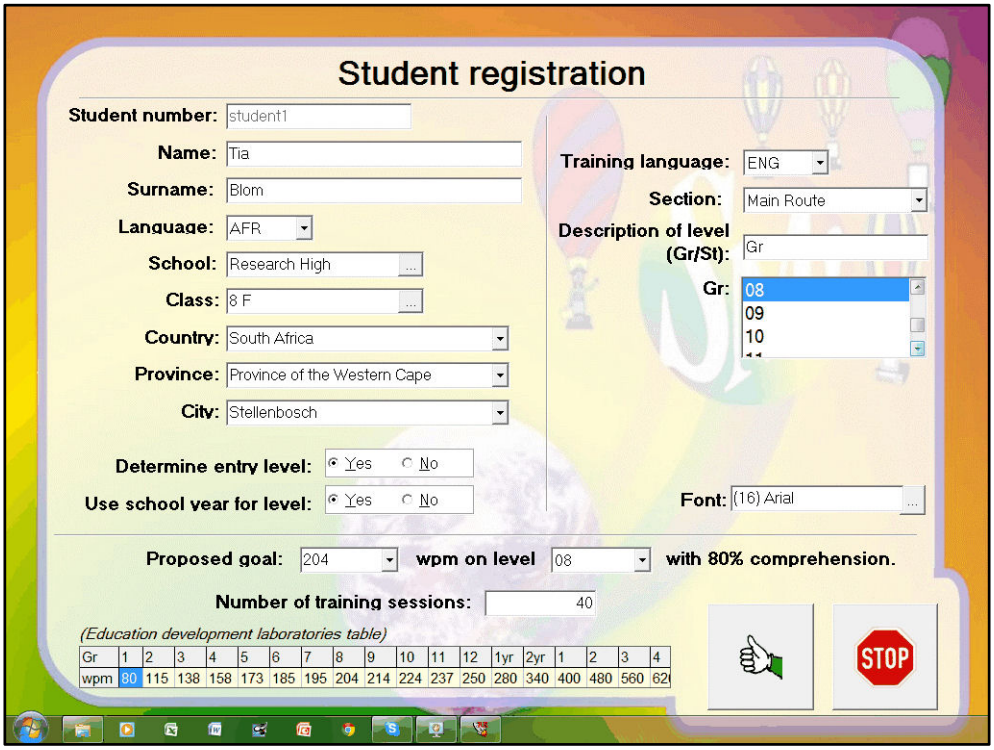


Figure 2 Log-in Page



4.1.1.2 Registration

Figure 3 Registration page



As can be seen from the screenshot, the student has to fill in his or her name, surname, school and name of the province in which they are. They also provide information about the languages they speak. First the learner specifies his mother tongue and then the language in which the lessons are to be conducted. It only offers an option between Afrikaans and English.

The next step is to determine that an entry-level test will be given and that the grade level of the learners is used to determine the level of difficulty of the entry-level test. This level may change depending on the skills of the learners.

The learner also has to fill in the proposed goal for words per minute. The registration page contains an indication bar at the bottom for users who are uncertain of the level. After all the information is correctly supplied the page diverts directly to the entry level comprehension test. Grade 8 learners should be able, according to this program, to read 204 words per minute.

4.1.1.3 Entry level ("Intreevlak")

At this stage the learner receives a reading comprehension test. Learners read at their own speed and proceed to the next 'page' by clicking on the arrow icon at the bottom right-hand corner. After they have read the text, they receive 10 multiple-choice questions. The program indicates whether the answer is correct or not by giving either a green correction mark or a red cross with a corresponding sound.

Learners must pass the entry-level test with at least 80%. If a learner does not achieve this the first time, the program automatically retests the learner at a lower level. This process can be repeated several times, until the learner is able to pass a test with the prerequisite 80%. The score is recorded in the white block at the bottom of the page. This pass rate can be changed under "Educator options" on the Main Index screen, which precedes the log-in screen.

Figure 4 Entry-level test

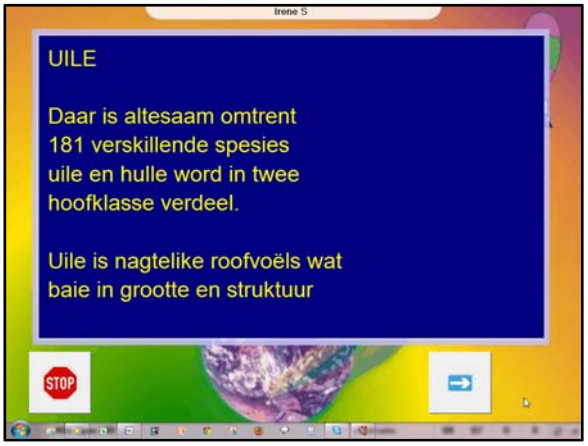


Figure 5 Comprehension Questions

The current colour settings are as follows: a dark blue background, bright yellow text and freesia pink highlighting. These are the default settings. They can be changed under "Educator Options" ("Opleieropsies"). It is advisable that they are changed because the yellow text develops a glare on the dark background that may affect the reading performance of the student.

When the learner does pass, the program automatically gives a dialogue box containing a summary of the time it took the learner to read through the text, the word count of the text and the WPM count.

Figure 6 Entry level summary

Only when the learners have passed the entry-level test can they access the other exercises. There are several exercises, as can be seen in the image below. All of them will be briefly discussed, but only the reading comprehension exercises will be discussed in detail.

Figure 7 Exercise index page

4.1.1.4 Development exercises

According to the developers all the exercises strive to improve reading comprehension, reading speed, motivation for reading, and spelling. The focus of this section will be the Preparation exercises ("Voorbereidingsoefening"), Flash exercises ("Flitsoefeninge") and Reading exercises ("Leesoefeninge"), but, firstly, here is a summary of all the other exercises.

Skills development exercises ("Vaardigheidsoefeninge")

There are five types of skills development exercises:

1) Eye warm-up,
2) Eye-span,

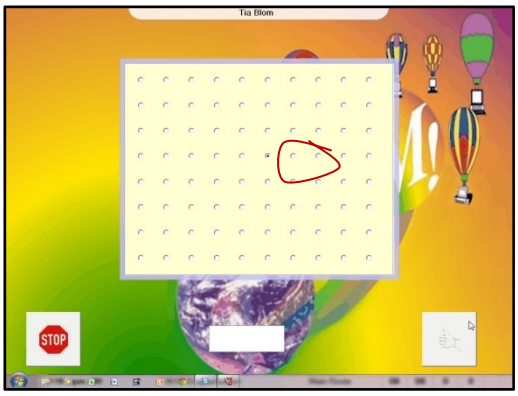
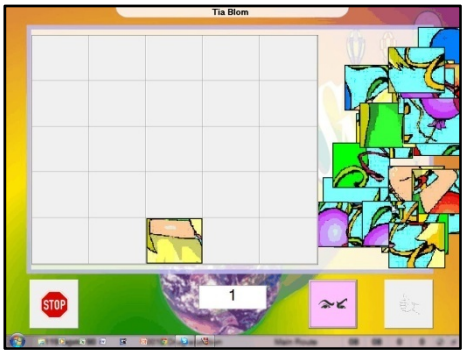
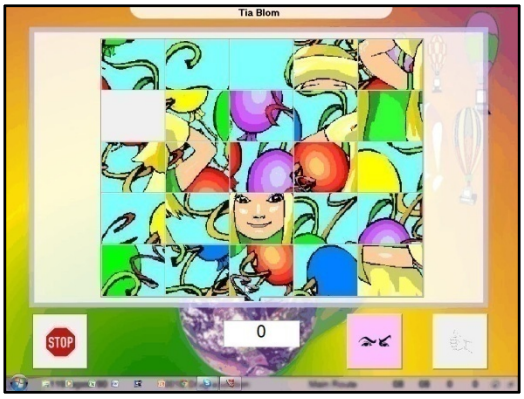
3) Mouse skills,
4) Thinking and Planning in the form of puzzles and
5) Short-term memory.

Each of these exercises serves to improve visual perception. The learner can exit these exercises at any time by clicking on the large STOP icon, so it is essential that the teacher monitor the students while they are busy. They should not quit too quickly nor spend too much time on them. Below is a table containing an example of each of these exercises with a concise explanation as to what is expected of the learner.

The quality of the visual material used in these exercises is questionable even though they are used for a good purpose. Learners today are used to high definition images and this fact has to be remembered when developing software containing visual aspects. A reason for the outdated graphics may be because the program was developed in 1998 and has not been revised since.

Table 8 Skills development exercises

Eye warm-up 	For these exercises the learner has to look at the middle block. The surrounding blocks flash for a 2000 ms. and the learner has to click on the block that is identical. The pictures on the blocks can be changed according to what the learner chooses. i.e. dots, forms, colours etc.
Eye-span 	For these exercises a series of numbers or letters are flashed and the learner has to look at them and type them in the box that is provided. The number of letters or numbers start at one and groups of five are flashed before the series is increased to two letters or numbers. The letters are random combinations and do not form actual words.

Mouse skills 	For this exercise the learner has to find the circle with the black dot and click on it. After every click the position of the black dot changes. The dot in this picture is in circled.
1. Puzzle (Pak)  ***2. Insert and Slide (Inlas/Skuif)*** 	The size of the puzzle ranges from 3x3 to 6x6. There are three kinds of puzzles that vary in difficulty: 1) Pack Puzzle, 2) Insert Puzzle and 3) Slide Puzzle. For (1) the learner has to transfer the scrambled blocks from the margin into the frame provided. For (2) the blocks are already in the frame with one block open. The learner can move them outside the frame in order to reshuffle them. The slide puzzle looks exactly like the insert puzzle at the beginning, but the learner can only use the open block to slide the pieces to their correct places. The pieces cannot be moved outside of the frame.
Memory game 	This is almost like the eye warm-up exercises in that it also has flash cards. The difference here being that there are more cards and have only pictures. Learners have to find pictures and match them. The number of turns is recorded. Less turns mean better memory; more turns mean learners need more practice.

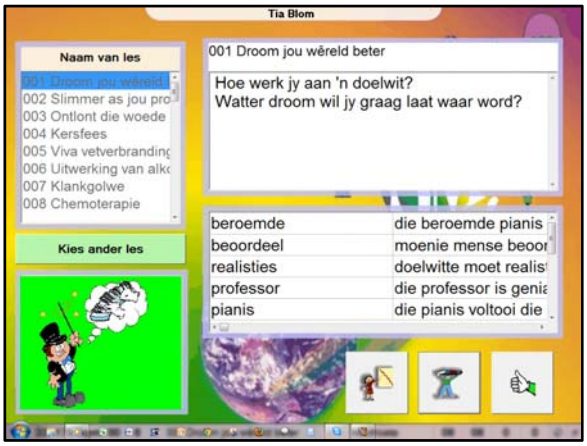
4.1.1.5 Preparing for Reading

a. Preparation exercises ("Voorbereidingsoefeninge")

A learner is presented with a question such as *"Hoe werk jy aan 'n doelwit? Watter droom wil jy graag laat waar word?"* The question is thematically related to the flash exercises and to the reading exercises, and subsequent language exercises. The learner has to read the question before reading the extracts that are provided in a table below the question. The words in the bottom table are words that appear in the text and they are contextualised within sentences so that learners may have a better idea of their use and meaning.

Theoretically these exercises are tied to the schema theory and psycholinguistic theory. The question itself may trigger some personal thoughts in learners' minds. There are many opportunities for expanding on this exercise in terms of group discussions and sharing personal experiences. Some of these words also appear in the spelling exercises, thus helping the learner recognise them more quickly.

Figure 8 Preparation exercise



Two areas of critique are offered: 1) Learners have to scroll horizontally because the sentences do not fit into the frame provided. This may cause them to focus on mouse-control rather than reading and remembering the facts provided. 2) As such, the preparation exercises do not provide much room for personal interpretation. It provides specific information about the reading comprehension that follows. As there may be limited space in a computer room, learners may not have an extended opportunity for group discussions on the theme provided by the exercise, so it is only useful for activating vocabulary and concepts used in the reading comprehension exercise.

b. Flash exercises ("Flitsoefeninge")

The flash exercises consist of words, phrases and sentences. It is almost like the eye-span exercises but it contains words. A word, phrase or sentence is flashed, and learners' have to type it verbatim into the block provided. The length of the words, phrases and sentences, increases with each correct answer and decreases with each incorrect answer. The words are initially flashed at 2000 milliseconds and are decreased by 50 milliseconds if the learner achieves more than 80%. The pictures in the top left corner are displayed according to the answer given by the learner; a 'happy' picture is given for a correct answer and a 'sad' picture for an incorrect answer.

Figure 9 Image 4.8.1. Flash exercises Index

Figure 10 Spelling

Figure 11 Phrase flash

Figure 12 Sentence flash

The more learners struggle the more flash exercises they have to do. Only when the learner achieves 80% or more for each section can he progress. After each section all the incorrect answers are given as 'Revision' so that the learner may receive a second or third chance at giving the correct answer. Once the revision exercises are given the score is set. The score does not change even when the revision is completed correctly.

Figure 13 Revision exercise

The lower-level cognitive skill of word recognition is the focus of these exercises. The increasing speed of these exercises help learners to develop automaticity in word-recognition. Such a skill, if well-developed will enable learners to use more cognitive processes for higher-order thinking skills. Refer back to section 2.2.4 for a detailed discussion on the different skills.

What may be considered as a downfall in these exercises is that the phrases occasionally contain typing errors such as double spacing between words. In order to progress to the next sentence learners have to purposely reproduce the same errors. Sometimes the sentences do not fit into the screen, causing continual incorrect answers as the learners are unable to see the whole sentence. In addition to theses mechanical detractors, the repetitive nature of the exercises do not promote language learning in any meaningful sense as the basis for the exercises are classic behaviourist drill-and-practice.

4.1.1.6 Reading exercises ("Leesoefeninge")

These exercises are the most important for the current research. The exercises take on the same format as that of the entry-level comprehension text, but the presentation differs. Also, the learner cannot follow the click-to-page method since the program automatically paces the text to change at the same speed which was determined at entry-level.

There are three ways in which to present the actual text: slot reading, line reading and full page. The Slot reading and Line reading can be done with or without background text. Each of these methods is recommended for different learners at different levels of comprehension.

Figure 14 Reading exercises Index

Figure 15 Slot reading without background ("Vensterlees sonder agtergrond")

Figure 16 Slot reading with background ("Vensterlees met agtergrond")

Figure 17 Line reading without background ("Lynlees sonder agterground")

Figure 18 Line reading with background ("Lynlees met agtergrond")

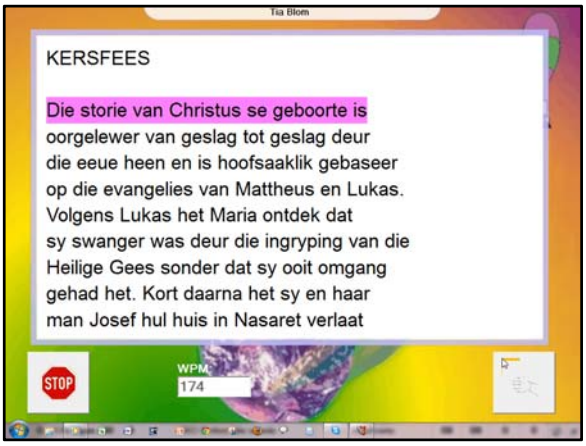


Table 4.2. Presentation of Reading exercises

SLOT READING		**LINE READING**	
Slot reading without background ("Vensterlees sonder agtergrond")		**Line reading without background ("Lynlees sonder agtergrond")**	
Method	**Purpose**	**Method**	**Purpose**
Only 2 and a half words (15 letters) are visible at any stage. The words move at the speed determined by the "determine entry level". Each time a learner re-enters *Reading Rocket* the speed is 'remembered' in the next section	This type of reading practises smooth eye-movements while reducing regressions and fixations. The back swing of the eye is practised.	Only 1 line is visible at any stage. The lines move at the speed up to where it incremented according to the learner's progress. As soon as the learner's eye-movements are smooth, and reading speed higher than the expected speed for his/her year-group, this type of reading can be offered.	Smooth eye-movements and especially the slight movement of the eyes from left to right is practised.

SLOT READING		LINE READING	
Slot reading with background ("Vensterlees met agtergrond")		**Line reading with background ("Lynlees met agtergrond")**	
Method	**Purpose**	**Method**	**Purpose**
The whole page is visible, but only 2 and a half words (15 letters) are highlighted at any stage. The highlighter moves at the speed determined at entry-level, or up to where it incremented according to the learner's progress.	As soon as the learner's eye-movements are smooth, this method can be offered. It still helps to reduce regressions and fixations. Smooth eye-movements and especially the back swing of the eyes are practiced. The benefit of this type of reading is that the learner is continuously aware of the fact that the words read are part of a sentence, and the sentence is part of a paragraph, which fits into the "story". (Holistic approach).	The whole page is visible, but only 1 line is highlighted at any stage. The highlighter moves at the speed up to where it incremented according to the learner's progress.	Smooth eye-movements and especially the back-swing of the eyes are practiced. The benefit of this type of reading is that the learner is continuously aware of the fact that the line read is part of a sentence and that the sentence is part of a paragraph, which fits into the "story".

Source: Engelbrecht (c), 2011

Each comprehension test is followed by a set of ten multiple-choice questions as illustrated in Figure 19. The score is kept in the white block as the learner answers the questions. The learner cannot page back to search for answers, so the questions have to be answered by memory and general knowledge.

Figure 19 Example of Multiple Choice question

There is a great variety of reading texts for the Afrikaans as well as the English lessons on *Reading Rocket* such as Christmas, the Science of Sound, Anger, Aids, Folktales. Each level of *Reading Rocket* has 40 reading texts from which the computer randomly selects one each time a learner logs on. The texts vary in difficulty and complexity of theme with the lower levels being written in a more conversational tone and the higher levels as expository pieces. The texts were not analysed in depth, as it is not the scope of this study.

The multiple-choice questions seem at first glance to be insufficient for testing reading comprehension, but when they are analysed according to Bloom's Taxonomy it is clear that they address the first two levels, namely "Remembering" and "Understanding" (see section 3.1.1.2). Of the ten questions asked about each text, most of the questions address factual information, for example, "Noem drie siektes wat 'n gevolg van min oefening kan wees". Some of the questions require that learners complete the sentence or fill in the missing words by using information from the texts such as "Mens weet dat kinders eet voor die TV omdat hulle...." [answer: "kake beweeg"]. Such questions entail that learners infer meaning from the text, so it may be classified as questions that test understanding (the second level of Bloom's Taxonomy). A small percentage of the questions asks for definitions of words from the text or that the learner makes inferences from the text such as when answering True/False questions.

Despite the fact that the questions are limited to ten per text and mostly test for factual knowledge from the text, learners still need to use many of the cognitive processes discussed in Chapter 2. Because they cannot refer back to the text when answering the questions, they need to pay more

attention to what they are reading, which makes greater demands on their working memory, as they need to remember the text while thinking about the questions. The success of these reading exercises depend on how well learners remember what they read, which in turn implies that they have to be able to recognise a large amount of sight words automatically (see section 2.2.4.2). Testing and developing automaticity in word recognition is the primary strength of these exercises.

4.1.1.7 Language exercises

There is a list of language exercises which are designed to develop hand-eye co-ordination, visual perception, letter-recognition and short-term memory. Many of these exercises are grounded in the writing principles discussed in Chapter 2. They strive also to make the learners aware of shape constancy such as in "Colour the letter" and "Decipher the word." Here is a list of the Language exercises:

- Colour the letter
- Decipher the word
- Scrambled words
- Find the words
- Can-you-read-me
- Complete the sentence
- Decipher the paragraph
- Guess the word

Figure 20 Colour the letter

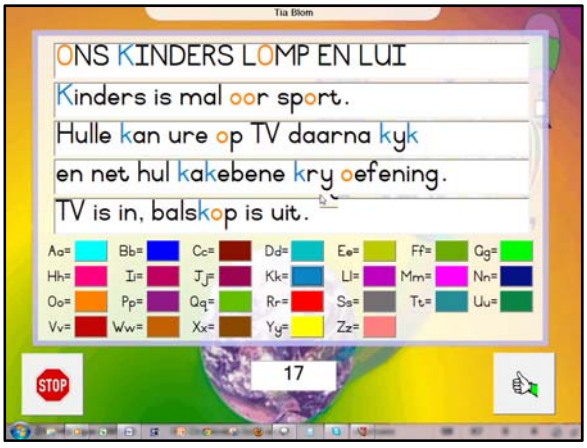


Figure 21 Decipher the word

"Decipher the word" and "Colour the letter" exercises make learners aware of the orthography of a language. These exercises may seem inappropriate for high school learners. They, however, help learners to realise that the orthography and spelling pattern of language is rule-bound. As remedial

intervention these exercises may help with the development of word recognition and fostering the principles of writing.

"Can-you-read-me" is an interesting variation of the Flash exercises. When the learner clicks on the thumb icon a word is flashed letter for letter at high speed and continuously. The longer the learner takes to identify the word and click on the stop button the slower the word flashes.

Figure 22 Can-you-read-me?

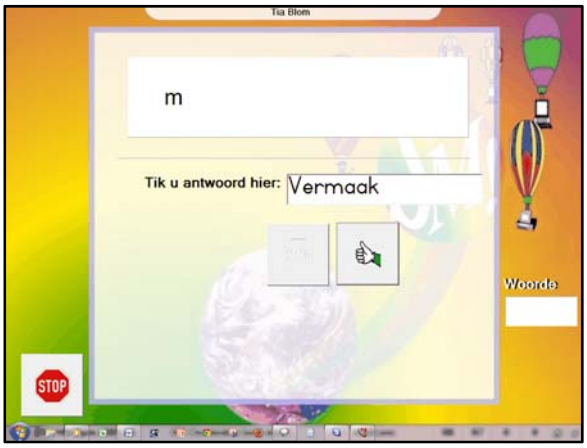


Figure 23 Find the word

These exercises have value, but there are some elements that could be changed for the better. For example the "Find-the-word" exercises only require learners to find words in a horizontal and vertical position and not in a diagonal position. Completing the sentence in the like-named exercise is also much easier because the spaces fit the word. One may argue that this helps learners to associate certain words with certain sentence positions, but it may also just teach them to match the size of the block with the size of the gap, thus failing to teach them the proposed grammar. The situation is exactly the same for "Decipher the paragraph."

4.1.2 Implementation of *Reading Rocket*

4.1.2.1 Training and Support

Training and support from *Reading Rocket* developers depend on the licence agreement. There are two types of schools using *Reading Rocket*: commercial schools and Khanya schools. Both schools may choose to implement the program as part of the daily curriculum at school, or as a remedial after-school program. There seems to be a difference in the cost and user support of *Reading Rocket* in these two options given to schools, and should therefore be discussed in greater depth.

The initial training for each school is different. National training sessions for teachers hosted in Pretoria took place in November/December 2010 and again in April 2011. The training lasted over a period of 10 days and cost R 5 750 per person. If teachers could not attend this training session,

they had the option of arranging private training sessions at schools. One school attended a week-end workshop facilitated by the developer at a nearby school where the program was already being used. Below is a table of the costs involved for these sessions according to the number of teachers who attended the training.

Table 9 Fees for private training in *Reading Rocket*-use

Number of teachers	***Amount payable***
1 – 15	R 20 000
16 – 30	R 25 000
31 - 45	R 30 000

Source: Engelbrecht (b), 2011

a. Commercial schools

Commercial schools pay a monthly fee according to the size of the school. The fee they pay includes training for one person. See below for a summary of these fees. For these fees commercial schools receive extensive support from the developers. A list of support services is given in the Table 11.

Table 10 Cost of program and services

Cost structure	***Category of schools (learners per school)***				
Number of learners	1-350	351 - 550	551-750	751 - 1000	1001+
Monthly service fee (10 months)	R 3500	R 4000	R 4500	R 5000	R 5500

Source: Engelbrecht (b), 2011

Table 11 Services for Commercial schools

Full program	Learning-to-read exercises and perceptual exercise (Foundation phase) Reading development exercises Advanced reading exercises Language exercises Spelling exercises Spelling marathon exercises
Annual updates for:	Lesson materials Program Training
Work books	Learning-to-read phase Teaching spelling
Scheduled visits	Supporting teachers Quality control

Source: Engelbrecht (b), 2011

b. Khanya schools

Khanya schools pay an annual licence fee of R 2000 which escalates with 10% per annum. As stated above, Khanya schools may receive the same initial training as the commercial schools, depending on what they can afford. Nonetheless, this is the only similarity between the two schools.

Since the WCED has undertaken to support the Khanya schools through the Khanya project, the *Reading Rocket* developers only provide the program. Initially the content of the program provided to the Khanya schools is similar to the content of the program provided to the Commercial schools. Unfortunately, as the Khanya schools reside under the WCED and not directly under the developers themselves, they are not provided with the annual program and lesson content updates. Consequently, the Khanya schools have an inferior version of the program which in turn results in inferior support for learners. As an end result learners from Khanya schools do not get as much support and value from the program as do students from commercial schools.

4.1.2.2 Implications

The difference in the services is ascribed to the difference in costs with regards to the licence fees. Given the substantial difference in cost it is safe to assume that the commercial schools are also the well-resourced schools. The Khanya schools are fortunate enough to pay a reduced fee, but they are

disadvantaged because they do not have full access to all the updates, training sessions and monitoring available to the commercial schools.

In my opinion the difference in cost becomes the deciding factor on whether or not to buy the program. If the program is found to be an effective intervention tool for addressing literacy, a school may be persuaded that buying the program is worthwhile, but if the program is found not to be as effective as developers claim it to be, schools may look elsewhere for more cost-effective means of intervention. One such rival to *Reading Rocket* is *Cami*, an educational software company that provides a wide range of educational software for free (Cami Educational Software, 2011).

CHAPTER 5: Methodology

The primary data for this study is quantitative as it works with the numeric results gained from *Reading Rocket* progress reports and paper-based tests written by the learners during the year. Quantitative data was considered as appropriate for the current study because the researcher wanted to evaluate the effectiveness of the program in the most objective way possible. As the study is grounded in the sphere of education and is, as such, a study concerned with people, qualitative data has been added in the form of interviews with schools in which reading and language problems and the use of *Reading Rocket* were discussed. See Addendum A for the questionnaire that was used in the collection of qualitative data.

Initially, research would have taken place at a school where learners had no prior experience in using *Reading Rocket*. However, permission for installing and using the program was denied by the developers on the grounds that the researcher had not gone through the necessary *Reading Rocket* training. According to the developer of *Reading Rocket,* the data gained from such an experiment would not be as valid as from learners whose teacher had been trained by them.

The change from collecting new data to analysing existing data was made on the basis that the data would reflect the daily use of the program by ordinary teachers in normal classroom circumstances. The circumstances under which the data was gathered would, therefore, be trustworthy because the learners were not exposed to an external researcher or unusual circumstances that could have an influence on the results. The change from new data to existing data was also considered as more favourable as the existing data covers a longer period of time which cancels out any effects that the novelty of using *Reading Rocket* would have had on the results of learners who were newly exposed to the program. The target school has been using the program on a daily basis for three years. This year Grade 8 and 9 learners have 2 periods of *Reading Rocket* in a cycle of 10 days.

The program has a built in recording system that the teacher uses to monitor the progress of each learner or each group. Group reports, similar to the one shown in Figure 23, were printed after the Grade 8 learners had done their entry-level test and then at the end of each term. The report includes information of the reading level of each learner, the level of comprehension on that reading level in percentage, reading speed in words per minute and the spelling score. An example is shown below.

Figure 24 Example of Group report

Class: 8 F

Stu No	Name / Surname	School	Class	Lang	Sch Level	Route / Section	Compr	WPM	Spell
student1	Tia Blom	Research I	8 F	AFR	Gr 08	07 Hoofroete	100	149	21
						Group average:	**100**	**149**	**21**

The learner Tia Blom is a fictitious learner and the information shown here was created specifically for research purposes. The table shows that the learner "Tia Blom" is in Grade 8. She reads at Grade 7 level, but has a comprehension score of 100% and a spelling score of 21%. Her reading speed is 149 w.p.m. If her spelling score were 80% or more she would have progressed to the next level, but given that the program calculates improvement not only for reading comprehension, but globally for all exercises, she cannot progress yet.

The *Reading Rocket* teacher provided the researcher with group reports for Terms 1 to 4 of 2010, and, Terms 1 and 3 of 2011 of the same learners (Grade 8 2010/Grade 9 2011). The program data for these six terms is compared to the corresponding paper-based test results for each term. The paper-based tests used for the comparison were the language tests (comprehension, summary and language) that learners wrote each term and these results were compared to the program data in order to determine any correlation between the results. The analysis of results is done in more depth in Chapter 6.

5.1 School profile

A school was chosen based on five factors namely type of school (i.e. secondary), location, technological resources, involvement with Khanya, and prior experience with *Reading Rocket.* The school in question is a high school with learners from Grade 8 to Grade 12 and is located in the Western Cape within a 100 km from the Cape Town Metropole. There are between 295-305 learners in the school for 2010 and 2011. It is classified as a fifth quintile school with a 100% Grade 12 pass rate for 2010 and 2011. The number of learners per class is below 30. Learners in Grade 8 and 9 buy their own textbooks, new or from other learners, but if they cannot afford them, they may borrow books from the school for a year.

The school has a fully functional, well-equipped media centre with enough computers thus enabling each learner to work individually. The school is part of the Khanya project and the school has been using *Reading Rocket* for the past three years. The learners are introduced to *Reading Rocket* when they enter Grade 8. They use the program regularly until the end of Grade 9. According to the

teachers, Grade 8 learners have considerable problems with reading comprehension on several levels of understanding. See Bloom's Taxonomy in section 3.1.1.1.

The target group is currently in Grade 9 but the bulk of data was gathered from their Grade 8 year (2010). In Grade 8, these learners were in three groups of 20, 22 and 24. In 2011 they are still divided into three groups of 24, 24 and 25. The group data was filtered by the researcher to exclude all the learners who had not been exposed to the program from the beginning of 2010 to the end of Term 3 in 2011, thus, only the results from learners present for the whole of this time frame were included in the study. After the filtering had been done the group totals at 61 learners.

5.2 School Resources

The school does not have a functioning library. The learners do, however, participate in the ATKV youth literature project. The ATKV (Afrikaanse Taal- en Kultuurvereniging) prescribes five books published the previous year. Learners have to enter for certain age groups and this particular school enters for Grade 8 to Grade 10. Learners have to read these books and write reports on them in order to enter for the ATKV youth literature prize.

The school has two computer rooms: one room has 35 computers and the other 25. The larger room is used by one of the teachers for Computer Application Technology (CAT) and Computer Literacy. The smaller room is used specifically for Mathematical Literacy and *Reading Rocket*. Usually no group is larger than 25, so that all the learners may have a computer for the whole duration of the period. That is why the Grade 9 group was divided into three groups and not two.

In 2010 the school timetable had a 5-day cycle with 6 periods in each day. Two periods per cycle was allocated to the use of *Reading Rocket*. The periods vary between 45-54 minutes each. In 2011 a 10 day cycle with 6 periods per day was followed. Three periods per cycle were allocated to Reading Rocket. The periods vary between 45-54 minutes each.

5.3 *Reading Rocket* in other schools

Reading Rocket has been in use since 2007 and many schools have had the opportunity through Khanya to use the program. Many of these schools are not using the program anymore, and three schools where the program had been used were chosen for a discussion opportunity between the researcher and the teachers. The goal of these discussions was to find out why they stopped using

the program and whether they found it useful. Other information of interest included the availability of technological resources and how teachers used them.

5.3.1 School A

School A is within the 100 km range of the Cape Town Metropole and is classified as a previously disadvantaged school. Six teachers, who primarily teach Grades 8 and 9, were present for the discussion: 2 Afrikaans Home Language and 4 English First Additional Language.

One of the Afrikaans teachers was sent on a three day *Reading Rocket* workshop whereas the training period is usually 10 days. The developer was present and led the workshop. The teacher had to report back to the other teachers from School A, after which they had to plan how to implement *Reading Rocket* as there are too few computers for the number of learners in each class.

Each Grade 8 and 9 class has an average of 45 learners each and the computer room has 22 computers which means that all the learners had to share and take turns using the computer. Each teacher only had 1 period in a cycle of 7 days in which to use *Reading Rocket*.

Each teacher had a different approach to dealing with the number of learners and computers. One English teacher split the group according to gender. Another teacher only used it for remedial purposes. Neither of these situations is ideal because one half of the class had to be left without supervision. One Afrikaans teacher took all of the learners at once and they had to take turns. During these periods there would be a facilitator present to help the teacher manage questions from learners and to keep track of where each student ended each session.

A facilitator from Khanya came at intervals to monitor the use of the program and to discuss the data gained from the abovementioned sessions with the teachers, but no in-depth analysis of the results was made or kept. However, some of the teachers' observations were that learners who are better achievers in other learning areas progressed much faster than learners who struggled academically in their other learning areas. The struggling learners became disheartened because they had to repeat the exercises so many times which means that the program failed to live up to the expectations of both teachers and learners.

Apart from the computer room, teaching is restricted to the blackboard and chalk. Other technological resources like data projectors have to be requested from the media room and no other up-to-date technology is available for use. The lack of technological resources means that most of the reading support given by the teachers is paper based. They usually make use of a Reading corner where learners can read newspapers and magazines. They also make use of the compulsory

reading journals for which learners have to read a specific number of fiction and non-fiction books per year and learners are required to keep a record of these books in the reading journal.

School A started using the program during the first term of 2010 and discontinued use at the end of 2010. The reasons for discontinuation were in part the licence fee that they could not afford and also the lack of resources and manpower. According to the teachers the ideal would be if they could have had an external person who came to school and took out the learners who needed the program for reading sessions. In so doing the teachers could then stay in their class.

5.3.2 School B

School B is situated in the same area as school A, but is classified as a former Model C school. One of the Afrikaans teachers shared her insights per e-mail. She teaches a class of 40 Grade 8 learners. The school switched from using *Reading Rocket* to using *Cami* because *Cami* is available for free. *Cami* is an educational software company that develops various products including *Cami* Reader (Cami Educational Software, 2011).

The teacher distinguishes between learners who are able to read fluently and learners who read with comprehension. These two types are not mutually inclusive. She specifically mentions that learners are unable to answer comprehension questions because they do not understand key concepts like compare, name, explain, causes, effects, identify. This is reminiscent of the words used in Bloom's Taxonomy (see section 3.1.2.2.1). She also mentions that learners rush through the questions causing them to make mistakes and misunderstand what is asked of them.

Her first cause for concern is the increased difficulty of addressing reading problems when a learner reaches adolescence because reading problems should have been remediated during the Foundation and Intermediate phases. High school learners need intensive remedial exposure, but the use of a remedial reading program during class time is difficult because the syllabus is so full.

Fortunately she also teaches computer literacy, so she had the opportunity to use the *Reading Rocket* with her Grade 8 group during some of these periods. To compensate for the full curriculum, learners with reading problems did not attend assembly on Monday mornings during which time they receive extra help with their reading and for help after school hours they use two non-school organisations that specifically address reading problems.

Lastly she voices her concern over the lack of specialist teachers. It is her opinion that the WCED should pay particular attention to addressing reading and literacy problems in schools by appointing teachers who are specifically trained to teach learners with these types of problems.

These two interviews serve to contextualise the specific context in which data was collected and give a better understanding of reading problems in other schools. It is necessary to understand how teachers currently attempt to address literacy problems before recommendations can be made about effective reading programs. These interviews do not give all the detail of a normal school day, but, nonetheless, highlight some of the issues that teachers want addressed by government. Before this can be done teachers need evidence about the effectiveness of the reading programs that are available.

CHAPTER 6: Data analysis and discussion

The next sections give an analysis and discussion of the data collected for 2010 and 2011. The program data analysis is given first, then the paper-based test data analysis and then the comparative analysis. The discussion of these data sets and comparisons are done in a separate section.

6.1 Analysis

Program data and paper-based test data are analysed separately in order to determine learners' progression in the program exercises separately from the paper-based tests, thus, making any trends in the results more visible.

The averages of each data set, program and paper-based tests, were used for the compilation of graphs in order to get an overall picture of the learners' achievements. Program data is depicted in one graph (Figure 25). The comparative test data is depicted in two separate graphs (Figures 25 and 26). Scatter plots show a comparison between program data and test data for each respective year. Each learner has a unique code to ensure anonymity.

6.1.1 Program data

A summary of the program data for all six terms was made and is shown in Table 12 below with a key for the abbreviations. The table contains information from the Grade 9 learners and only serve as an example of how the program data was summarised. The summary includes the learners' unique codes, what class they are in and information of the six group reports that the teacher retrieved for each term. An explanation of the information is given below the table.

Table 12 Example of program data summary sheet

		2010																2011							
		ENTRY 1: 2-3-10				TERM 2 16-4-10				TERM 3: 13-7-10				TERM 4: 13-9-10				TERM 1: 14-2-2011				TERM 3: 21-9-2011			
Learner code	Class	R	C	W.P.M	S	R	C	W.P.M	S	R	C	W.P.M	S	R	C	W.P.M	S	R	C	W.P.M	S	R	C	W.P.M	S
M6	D	5	70	90		5	100	119	100	5	100	130	100	7	70	108	100	7	50	114	100	6	100	134	85
K7	D	7	80	117		6	100	162	72	4	90	199	100	8	80	123	70	6	100	239	80	5	40	154	90
T1	D	8	80	57		6	70	162	100	5	50	151	100	6	50	143	90	8	40	101	0	7	80	132	90
H1	D	5	80	258	100	3	90	298	100	3	100	216	100	4	100	271	90	5	42	174	0	3	70	185	100
E2	D	8	80	142		6	70	154	80	6	80	163	100	5	70	168	80	7	50	148	100	6	80	153	80
F2	D	6	80	114		6	80	124	90	6	100	123	77	8	60	91	90	7	80	126	90	6	80	169	90
A1	D	6	70	25		6	70	111		5	60	145	80	6	60	170	80	6	90	164	100	7	20	11	80
H5	D	8	50	44		6	90	110	100	6	100	105	90	8	70	57	90	9	33	61	70	6	100	186	90
C9	D	8	42	66		6	80	124	90	6	90	122	70	5	100	115	80	6	80	127	100	5	100	205	80
K5	D	6	90	125		6	70	153	100	5	80	169	90	7	90	141	90	8	70	127	90	7	50	172	80
B6	D	6	90	194	100	6	80	209	90	6	60	189	88	8	70	194	100	8	90	245	66	7	80	233	90
P1	D	8	40	99	60	6	90	94	100	6	80	125	100	6	50	155	60	6	70	114	80	6	90	167	90
O1	D	7	80	94	100	5	100	117	90	5	100	112	90	6	80	158	90	8	30	96	100	6	100	201	100
L2	D	6	80	137		5	90	110	80	5	100	111	100	5	57	97	25	6	90	98	90	5	70	83	75
E3	D	7	70	141	80	7	70	160	90	7	70	153	100	7	50	142	100					9	75	177	90
F3	D	6	60	144		6	90	139	80	6	90	167	100	7	70	133	70	6	80	180	100	8	70	71	100
B1	D	3	80	102		4	100	129	90	4	80	158	80	4	60	180	75	6	90	170	100	5	100	121	100
H3	D	6	80	74	100	6	60	65	100	6	100	83	77	7	100	116	88	7	70	110	90	6	90	191	100

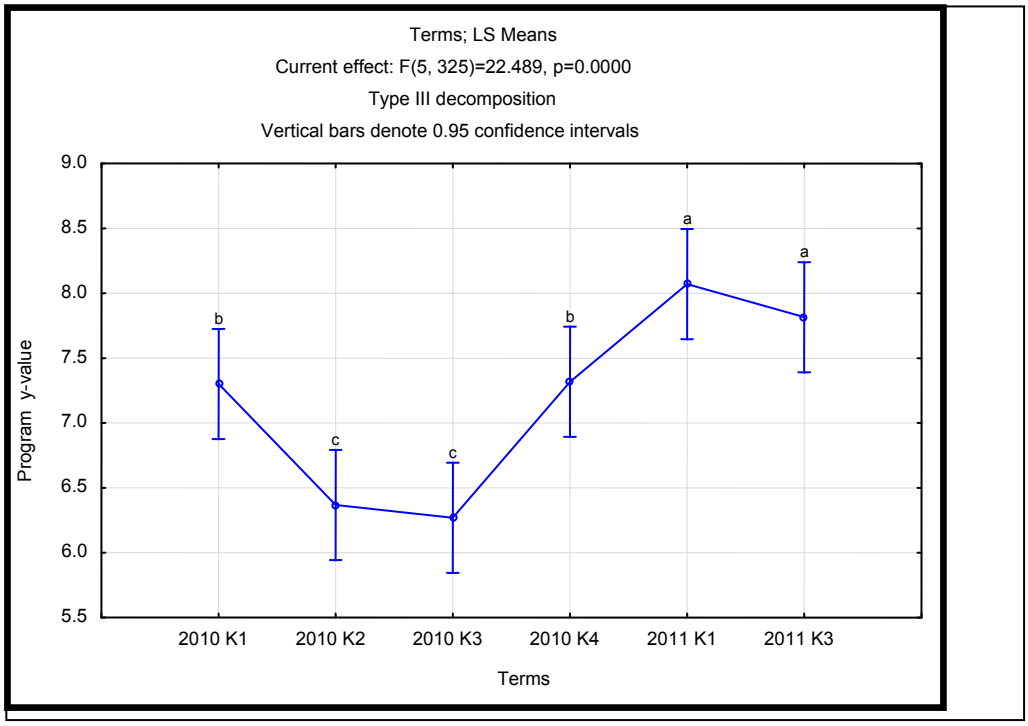
R	Route according to grade level of reading comprehension
C	Reading Comprehension exercise score (%)
WPM	Words per minute
S	Spelling

The route (R) indicates the level of comprehension of the child and is matched to the grade level on which the learner performs, for example, learner M6, who is now in Grade 9, had an entry level route score of 5 in Grade 8, meaning that his comprehension level is on Grade 5 level. The comprehension (C) column indicates the percentage that the learner achieved on route 5. For M6 it is 70%. This means that he had to do route 5 again until he scored a C-count of 80% or higher. M6 scored a 100% on route 5 in Term 2 and Term 3. Only in Term 4 did he score 70% on route 7. This means that he read with 70% comprehension on Grade 7 level.

In raw form the C columns of each learner cannot be compared with one another, because a score of 70% on route 7 is higher than a score of 100% on route 5. Therefore, the formula $y = R + \frac{C}{100}$ was used to determine a y-value that is comparable to one another. If a learner scored a 100% on a route the value was rounded up to the next level. M6 therefore scored 5.7 for the Entry level, 6 for Term 2, again 6 for Term 3 and 7.7 for Term 4. An average was calculated for each term.

The averages are plotted on a graph (Figure 25) below in order to illustrate how they varied. The x-axis indicates the term intervals, which are indicated by a K-value preceded by the year, and the y-axis indicates the average value as calculated by the abovementioned formula.

Figure 25 Program data averages



As is clear from the graph the average fluctuates significantly over time and does not show the steady increase one would hope for. Table 13 shows the precise average program score for each term.

Table 13 Program data average per term

Term	Average value
2010 K1	7.3
2010 K2	6.4
2010 K3	6.3
2010 K4	7.3
2011 K1	8.1
2011 K3	7.8

Averages are rarely exact and when improvement has to be measured, it is necessary to know whether a difference from one term to the next can be considered as significant or not. Thus, the LSD test was performed to determine by how much the values between each term differs and whether the differences are significant, or not. The differences are calculated as a p-value. The p-values for each pair are indicated in Table 14 and in order to facilitate comparison, the similar terms and their p-value are listed below this table.

Table 14 LSD test for program data

Cell No.	LSD test; variable program y-values 2010 & 2011 Probabilities for Post Hoc Tests Effect: time Term	{1} 7.3012	{2} 6.3680	{3} 6.2697	{4} 7.3177	{5} 8.0708	{6} 7.8155
1	2010 K1		0.000029	0.000004	0.940174	0.000531	0.019955
2	2010 K2	0.000029		0.655021	0.000021	0.000000	0.000000
3	2010 K3	0.000004	0.655021		0.000003	0.000000	0.000000
4	2010 K4	0.940174	0.000021	0.000003		0.000694	0.024257
5	2011 K1	0.000531	0.000000	0.000000	0.000694		0.246456
6	2011 K3	0.019955	0.000000	0.000000	0.024257	0.246456	

Each term average is compared to every other term in turns to determine which terms are significantly similar and which terms are significantly different. The null hypothesis for this comparison is that the average between two pairs remains the same and is rejected if $p<0.05$ which means that there was a significant difference between the two K-values. If $p>0.05$ the hypothesis was accepted, which means that the two values were significantly similar. For ease of reference the pairs with no significant difference are indicated by the same letter on the graph indicated in Figure 25.

The p-value for 2010 K1 and 2011 K3 is 0.019955 and according to the y-values calculated by $y = R + \frac{C}{100}$ there is a difference of 0.5 between 2010 K1 and 2011 K3. Because $p<0.05$, the null hypothesis is rejected, meaning that the difference between the averages for these two terms is significantly different.

Before a comparison can be made between this data and paper-based test data, the next section will focus on paper-based test data.

6.1.2 Paper-based test data

The paper-based test data was gained from the results of written tests during the year. The tests written for exam purposes consisted out of a comprehension section and a language section. The control tests were only comprehension tests.

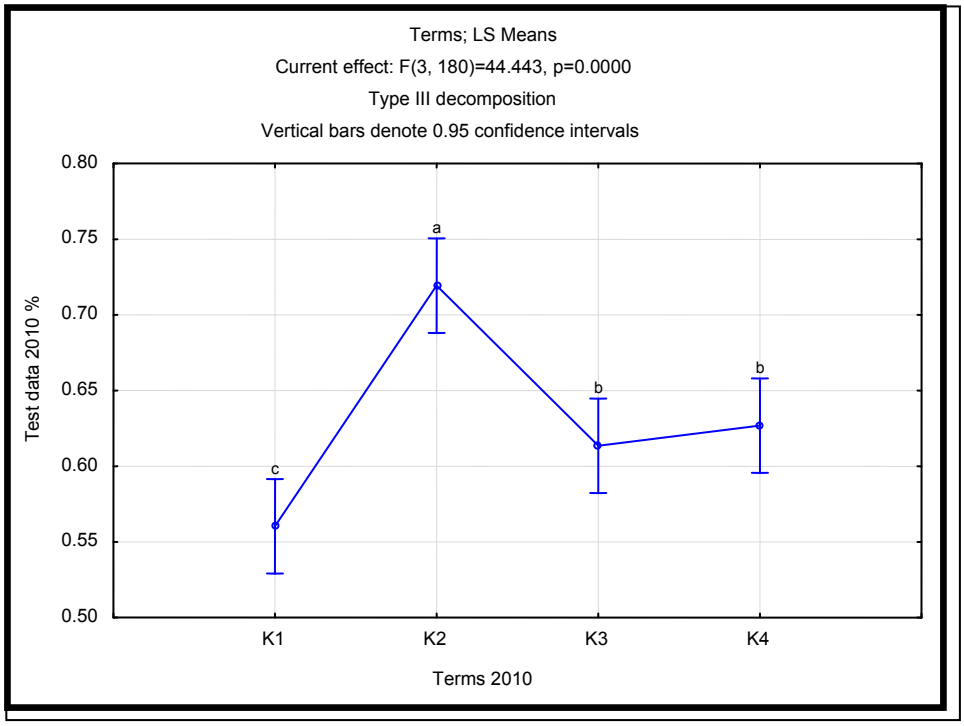
The test data was split according to year and plotted on two separate graphs (Figures 26 and 27), but a summary was made of the results in percentage of all six terms, as indicated in Table 15. Again the Grade 9 D class is used as an example to show how the data was summarized.

Table 15 Example of paper-based test summary sheet

Learner code	Class	2010 K1 %	2010 K2 %	2010 K3 %	2010 K4 %	2011 K1 %	2011 K2 %	2011 K3 %
M6	D	61	88	60	61	40	60	30
K7	D	61	83	60	66	25	50	35
H1	D	61	57	56	59	50	47	55
F2	D	58	78	66	64	60	63	75
A1	D	34	58	67	47	40	63	65
K5	D	48	70	54	52	70	50	60
B6	D	58	85	59	61	55	40	0
O1	D	50	52	36	58	65	50	40
L2	D	51	62	34	57	45	80	85
F3	D	58	63	54	54	75	70	85
B1	D	43	82	67	51	50	50	45
H3	D	56	62	44	59	50	60	60

These results are plotted on separate LSD graphs (Figures 26 and 27). The average are shown on the y-axis and the time on the x-axis.

Figure 26 2010 paper-based test data



P-values were calculated for all the pairs in order to determine which term results were significantly different and which were significantly similar. These results are given the same letters for ease of reference. Table 16 below provides the exact percentage scored in each term.

Table 16 2010 Paper-based test data averages

Term	Average %
K1	56.04
K2	71.94
K3	61.36
K4	62.69

The p-values that indicate the difference between the term pairs for 2010 are indicated in Table 17.

Table 17 P-values for 2010 paper-based tests

Cell No.	LSD test; variable paper-based tests 2010 Probabilities for Post Hoc Tests Effect: time				
	Term	{1} .56033	{2} .71940	{3} .61358	{4} .62689
1	2010 K1		0.000000	0.000201	0.000004
2	2010 K2	0.000000		0.000000	0.000000
3	2010 K3	0.000201	0.000000		0.344399
4	2010 K4	0.000004	0.000000	0.344399	

Again p-values < 0.05 are considered significantly different and p> 0.05 are considered significantly similar. K1 and K2 have significantly different values. There is a rise of 15.9% from K1 to K2. There is a significant drop of 10.58% from K2 to K3. K3 and K4 are significantly similar as it differs only with 1.33%. The p-value of this last pair is 0.344399.

The next figure (Figure 27) shows the graph for the paper-based test data for 2011 and Table 18 shows the actual percentage for each term.

Figure 27 2011 Test data

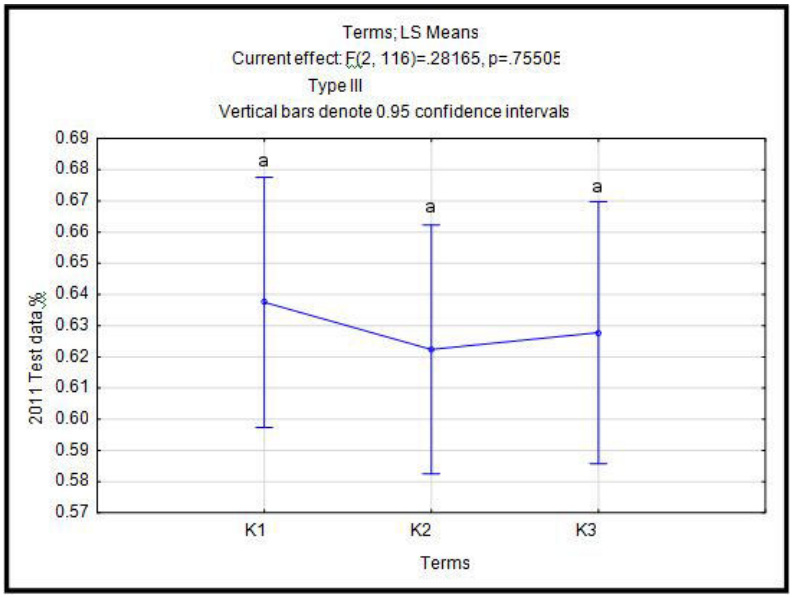


Table 18 2011 Paper-based test data averages

Term	Average %
K1	63.73
K2	62.22
K3	62.91

K1 and K2 differ with only 0.74% and K2 and K3 differ with 0.69%. K1 and K3 differ only with 0.05%. According to the p-values (see Table 19) none of the terms show significant difference in score, therefore the null hypothesis is accepted.

Table 19 P-values for 2011 paper-based test

	LSD test; variable paper-based tests 2011 Probabilities for Post Hoc Tests Effect: time			
Cell No.	Term	{1} .63748	{2} .62240	{3} .62775
1	2011 K1		0.459477	0.650399
2	2011 K2	0.459477		0.801704
3	2011 K3	0.650399	0.801704	

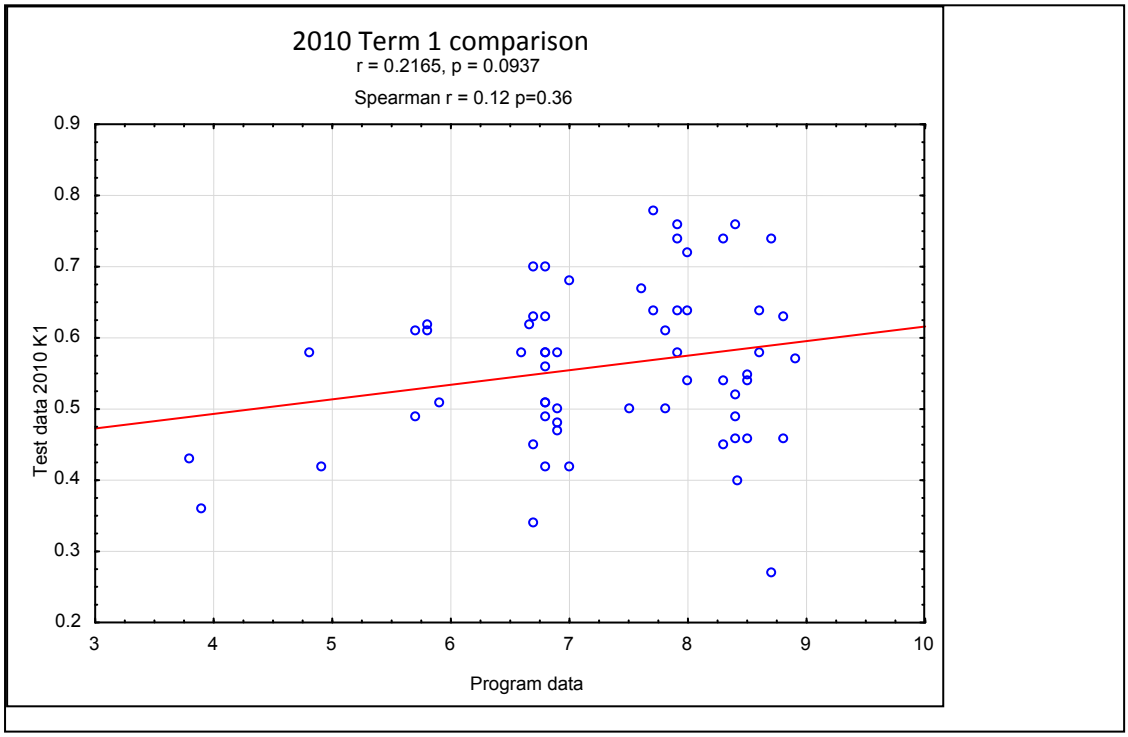
In order to address the hypothesis on which this research is based (see section 1.2), a comparison has to be made between the program data and paper-based test results. In the next section this comparison is made. A discussion of these results is given in a later section. The next section contains the results of the comprehension tests that were used as comparison for the program.

6.1.3 Comparison

For the comparison, program data and test data were paired according to the term in which they were collected. Spearman's Rank Correlation Coefficient Test (r) was performed on the pairs of data. Spearman's test hypothesizes that there is no correlation between the data. The correlation is indicated by r in the equation: $-1 \leq r \leq 1$, with ±1 being the strongest correlation to each respective side of the spectrum. The p-value is also given as extra support for the correlation.

Figure 28 shows the comparison between the program data and test data for the Entry test (K1).

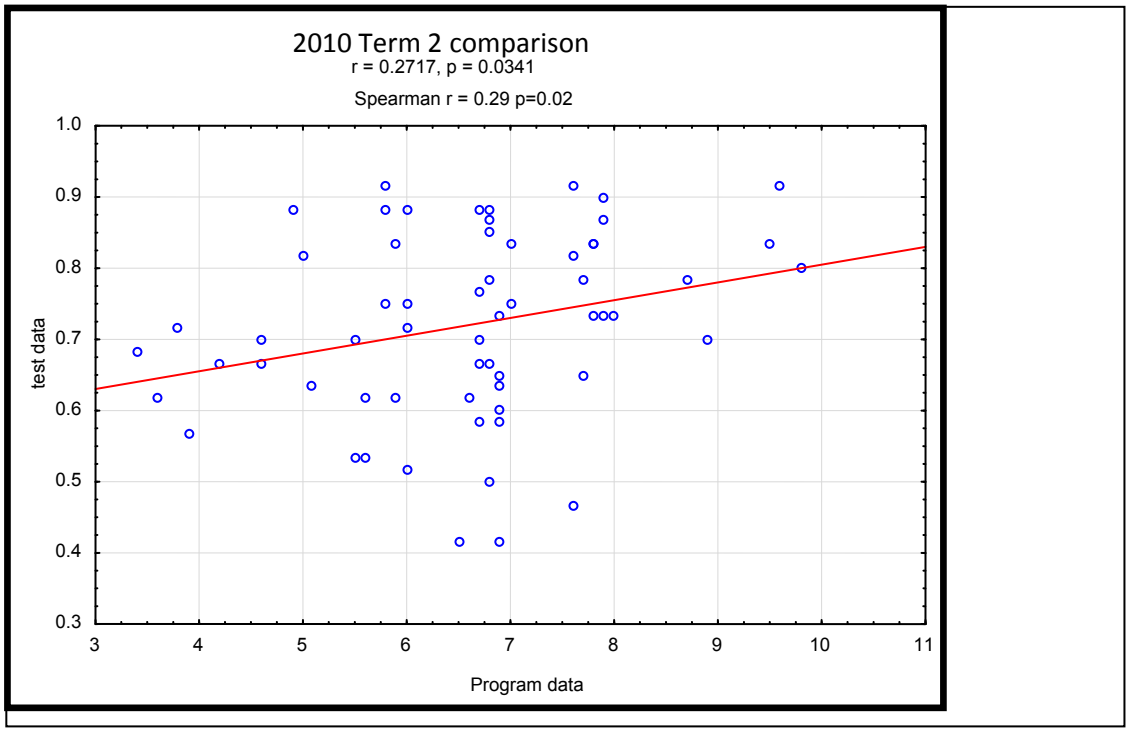
Figure 28 2010 Term 1



For this test r=0.12 which is smaller than 1 meaning that there is a very weak or no correlation between the program data and test data. This is supported by p=0.36. The null hypothesis that there is no correlation, is accepted.

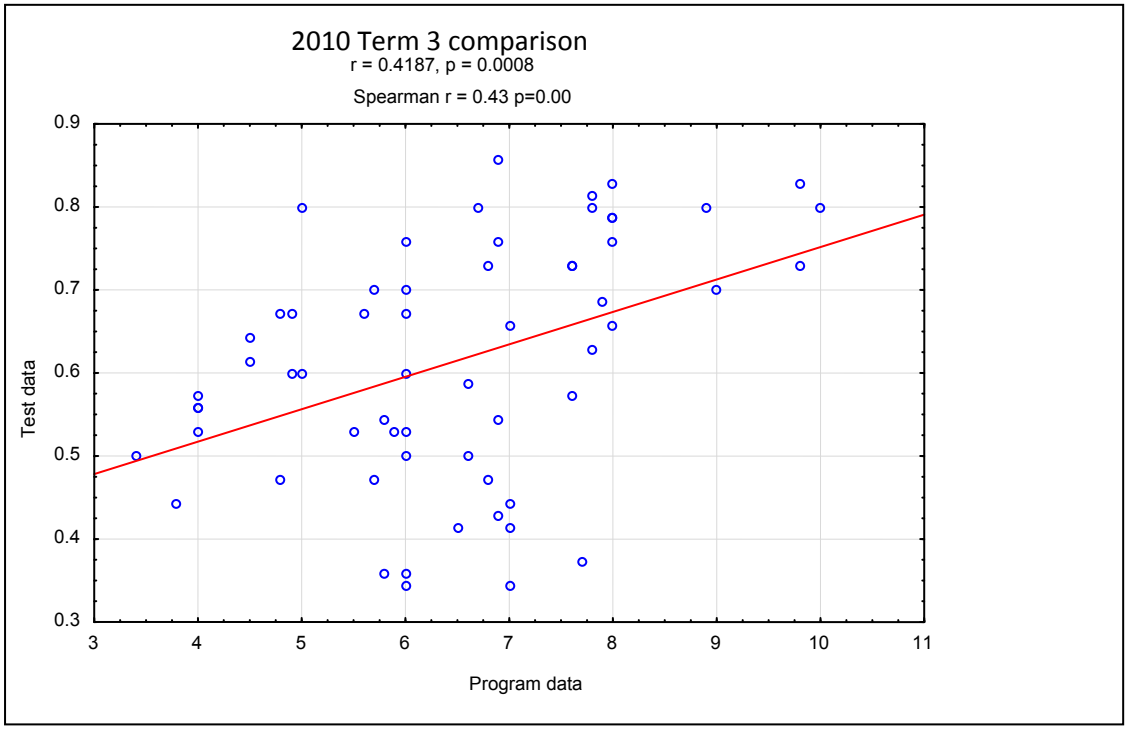
Figure 29 shows the comparison between 2010 K2 program data and paper-based data.

Figure 29 2010 Term 2



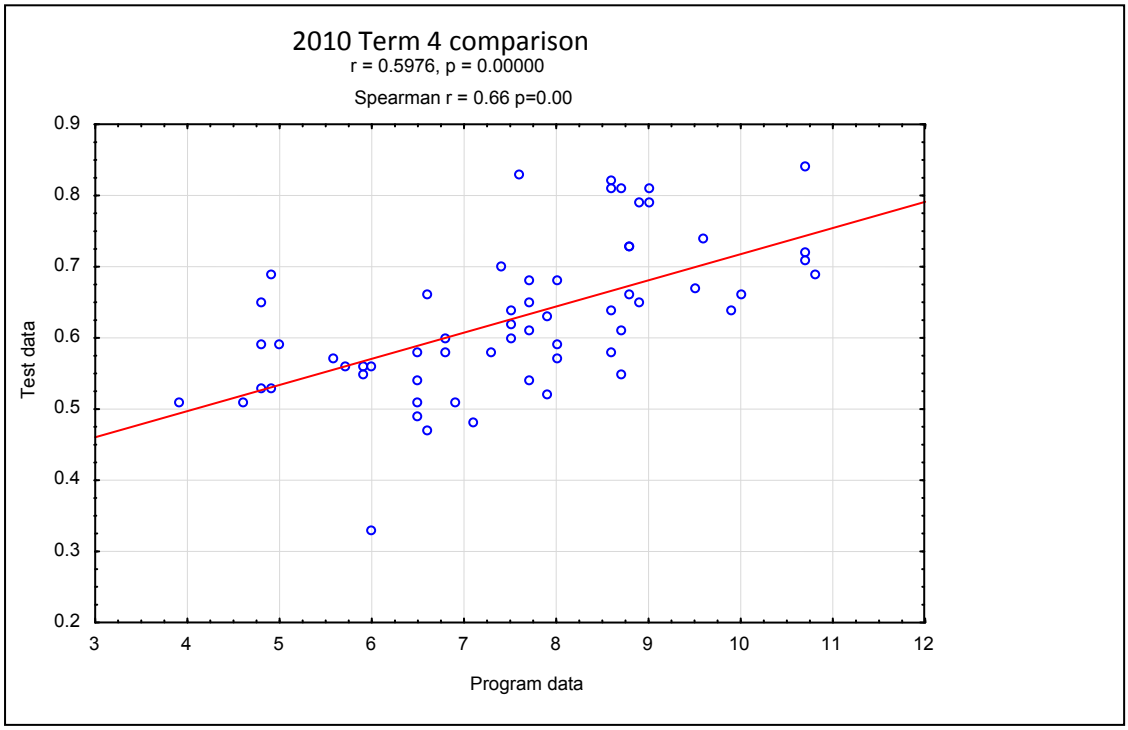
In Term 2 r=0.29 and p=0.02. According to the Spearman score the correlation is still weak, but the p-value is smaller than 0.05 indicating that there is a correlation between the program data and the test data. Figure 30 shows the correlation for Term 3.

Figure 30 2010 Term 3



In Term 3 the correlation between the data improved. r=0.43 and p=0.00. The Spearman coefficient is much closer to 1 than it was at the end of Term 1 indicating an improvement. This is supported by the graph showing the test data (see Figure 26).

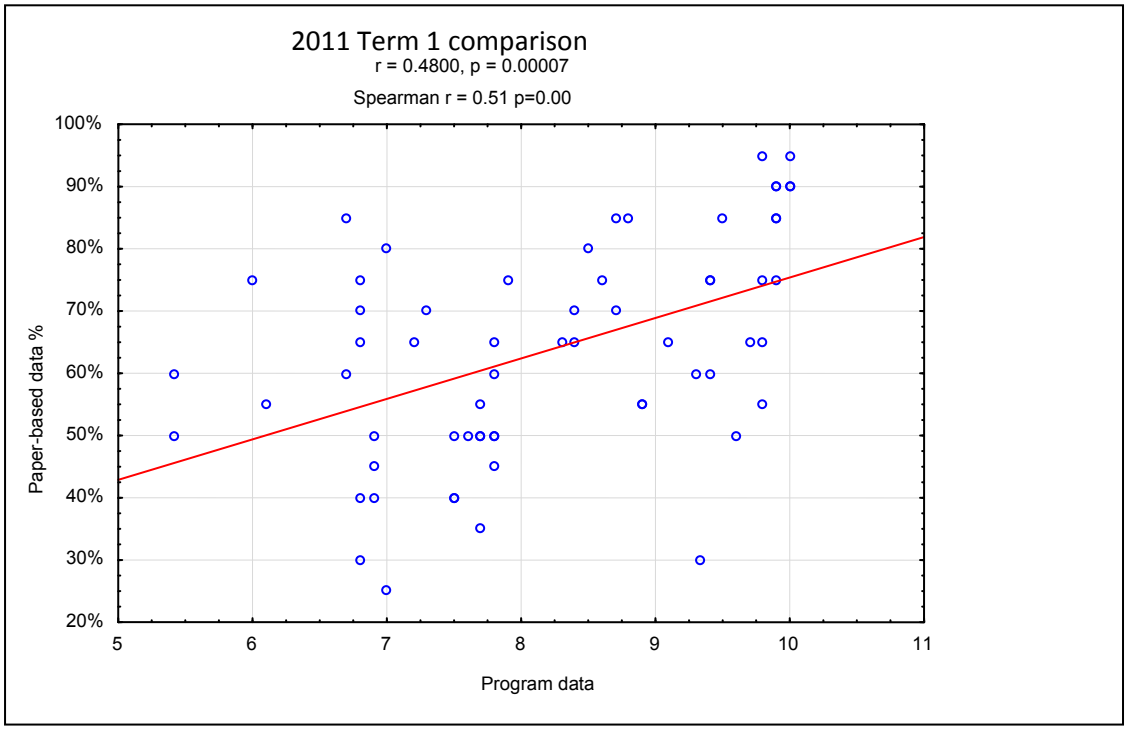
Figure 31 2010 Term 4



Term 4 shows the strongest correlation with r=0.66 and p=0.00. These results were obtained at the end of the fourth term. If compared to the graph in Figure 25 there seems to be a disparity, but the Spearman score only indicates that there is a much closer correlation between the program results and the test results in Term 4 than there was in Terms 1 and 2.

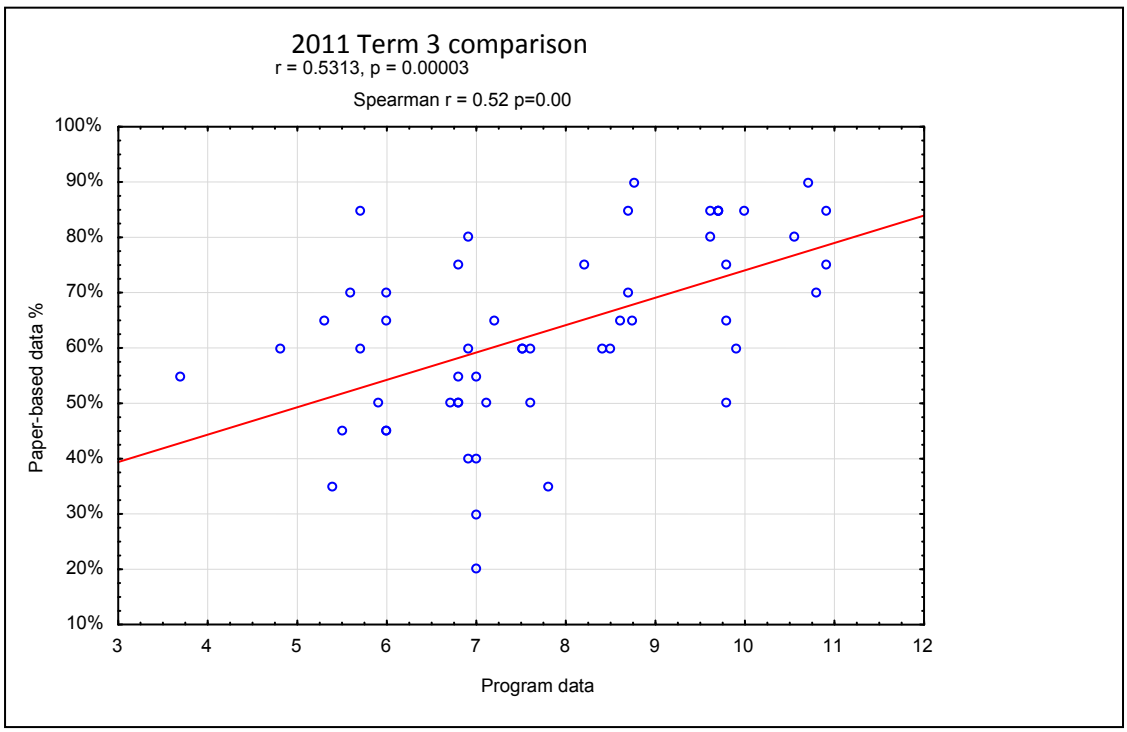
The next two figures are scatterplots drawn from program data and test data from 2011. No program data was available for the second term, therefore only data from Term 1 (Figure 32) and Term 3 (Figure 33) are shown below.

Figure 32 2011 Term 1



Results show that p=0.00 and r=0.51. The correlation is still positive but slightly weaker than that of the Term 4 in 2010. This data pair is composed from the Term 1 (K1) comprehension test and the program data report from the end of the first term.

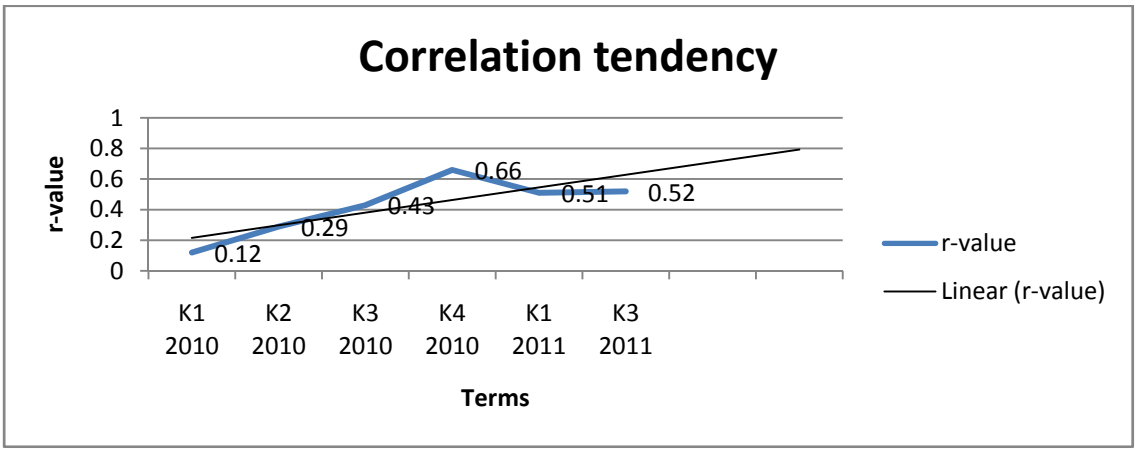
Figure 33 2011 Term 3



The correlation for the third term has r=0.52. It is almost the same correlation as that of Term 1 of 2011. The correlation is still positive, but not as strong as Term 4 of 2010. All terms, except Term 1 2010, show positive correlations.

For the computation for the comparative results, program data results were paired per term with the corresponding paper-based data results. A correlation of each pair was calculated and visually depicted by using scatter plots. The graph below shows how the correlation of each pair has strengthened over time and includes a forecasting trend line to show how it may progress in the future.

Figure 34 Correlation tendency



After the initial negative "no correlation" in Term 1 2010, the r-values show a steady increase for Terms 2 and 3 and a sharper increase for Term 4. In 2011 there is a drop, but it stays the same until the end of the third term. The deductions that can be made based on the statistical analysis are discussed below.

6.2 Discussion

The hypothesis on which the present research is based is that *Reading Rocket* is an effective intervention tool for teachers to use when working with learners who struggle with reading. The previous section provides an analysis of the program data, the test data obtained in the classroom and the comparison between the two. This section focuses on the deductions that can be made about the effectiveness of *Reading Rocket* based on the analysis.

The school from which the data was collected is a school of which all the Grade 8, 9 and 10 learners have been exposed to *Reading Rocket*, therefore, no control group was available against which to test the results obtained from the experimental group and such a control group could not have been

situated in another school due to the numerous variables that could affect the data. The effect of only having one group is discussed below.

The program data shown in Figure 25 fluctuates significantly from 2010 Term 1 to 2011 Term 3. It has been stated in the analysis that the LSD test helps to determine which terms differ significantly and which are significantly similar. For the current study the p-values obtained from the LSD test help to determine which terms indicate an improvement or a decrease in marks. The results for 2010 K1 and 2010 K4 are significantly similar, meaning that the learners end 2010 on the same level as they started using the program. In 2011 the results show significant improvement, only to drop again at the end of Term 3. There is, however, a general upwards tendency in the results, which indicates a slight over-all improvement.

The paper-based test data for 2010 also show fluctuation, which may largely be contributed to the inexperience of the teacher. As 2010 had only been her second year of teaching, the test papers may not have been of the same difficulty. This conclusion is statistically supported by the sharp increase from Term 1 to Term 2, which may be due to an easier test during the June exam. The drop in average from Term 2 to Term 3 gives further support of an easier June exam. Nevertheless, the significant difference between Term 1 and Term 3 does show an improvement of 5.32% in the averages, which may be contributed to learners' improvement in test results. The p-values indicate that the averages of Term 3 and 4 are statistically regarded as being constant and, therefore show neither improvement nor decline. However, the final average being 62.69%, there was, as with the program data, a slight overall improvement from Term 1 2010 to Term 4 2010.

The paper-based test data for 2011 is considered statistically constant meaning that learners' results neither improved nor worsened. The stability may be largely contributed to the change to a more experienced teacher. As data collection was only done until the third term, the results from the fourth term could not form part of the research and as such it cannot be determined whether the fourth term would show improvement or not. It is the hope that the final fourth term average would show improvement.

The ideal graphs for both the program data and the paper-based data would show a steady increase from the beginning of 2010 until the end of 2011 and not fluctuate as it does in the study. Such ideal graphs are rarely obtained, as there are many influences to consider, such as the level of difficulty of each test and learners' emotional, cognitive and physical state on the day that the test has been written. As there is no steady increase, it is crucial to discuss the correlations between program and paper-based data, so as to determine whether the program is an effective intervention tool or not. These correlations are discussed next.

The first term of 2010 in which learners did the entry-level test showed no correlation between the program data and the paper-based data. There may be two reasons for this: 1) learners have not yet had enough experience with *Reading Rocket* to use it with confidence and 2) test result may not correlate with the program results because learners were still adapting to a new school environment which influenced the way in which they scored in the test.

There is a positive trend to the correlations between the program and the paper-based tests for the rest of 2010 with a steady increase until the end of Term 4 which shows a correlation of 0.66. Due to the numerous emotional, physical and mental factors that may influence learners every day at various degrees, the steady increase in correlation indicates that it is not mere chance, but that the program results adequately reflect their test results.

The drop from Term 4 2010 to Term 1 in 2011 may be contributed to the adjustment that learners have to make from one grade to another. Some learners do not handle such a transition well and stress of this kind automatically affects their test results. Unfortunately, no program data was available for the second term, therefore it is not known whether the correlation experienced another drop or remained constant. Nevertheless, there is a slight increase in correlation between Term 1 and Term 3 which indicates a return to earlier stronger correlations. The forecasting trend line gives a global trend from the beginning of 2010 to Term 3 of 2011 indicating that despite the slight drop in correlation that the program may still be used effectively in the future.

The analysis shows a positive result in that the program and paper-based data positively correlate with each other, thus strengthening the conclusion that the program may be used as a tool for determining the level of reading comprehension and intervention methods may be implemented in class. Because of the lack of a control group, it cannot be determined whether the program helped to improve learners' reading ability.

CHAPTER 7: Conclusion

This study forms part of a national concern for the poor literacy skills of South African learners and offers one avenue for addressing the educational challenges at the heart of this issue by means of technology and reading comprehension software. As a conclusion to the study the following topics will be briefly summarised:

- The salient points discussed in each chapter,
- The contributions of the study within the South African context,
- The limitations of the study,
- The implication of the study on teaching practice and,
- Possible areas for improvement and future research.

7.1 Chapter summary

In Chapter 1 the motivation of the study is stated as a concern for the worsening literacy skills of high school learners. The validity of this specific concern is supported by statistics drawn from the 2011 ANA results. The study is based on the question of whether a digital reading program can be used effectively as an intervention tool to improve learners' literacy skills in areas away from the computer.

The literature review was divided into two chapters, with Chapter 2 giving an overview of the complexities of reading. It was discussed how the ability to read is not acquired like an L1, but has to be learned and that it comprises of neurological processes as well as cognitive skills. Grabe's analysis (2009) of the lower-level and higher-level skills was used in the discussion on the cognitive aspect of reading. Some theories and models were discussed, such as the Psycholinguistic theory and the Two-Model Theory.

Chapter 3 focused on the development and application of CALL. It was discussed how technological developments influenced the way in which language classes were conducted, for example, the earlier mainframe computers which only allowed for drill-and-practice exercises. The language learning theories of Behaviourism and Constructivism were discussed and were linked to classroom practice through discussing the phases of CALL as postulated by Warschauer (1996) and Bax (2003).

Chapters 4 and 5 focused on *Reading Rocket* and how it was used in the study. Chapter 4 gave an overview of the structure of *Reading Rocket*, but specifically focused on the reading exercises, while also describing the role of Khanya in the distribution of the program. Chapter 5 gave a description of the target school of the study and also how *Reading Rocket* was used in other schools.

Chapter 6 discussed and interpreted the data that was obtained from the target school. It was concluded that without a control group it cannot be unequivocally concluded that *Reading Rocket* is an effective intervention tool, but only that it is an adequate tool for teachers to use when they want to determine the level of reading comprehension of learners.

7.2 Limitations, Contribution and Implications

There are two main limitations to this study. The first limitation, as previously stated, is the lack of a control group. The initial research plan was to use two groups of learners, taught by the same teacher, from a school that had not previously implemented *Reading Rocket.* One group would have been the experimental group and the other the control group. The fact that these two groups are taught by the same teacher ensures that differences in results are not due to teaching style, but more likely to be ascribed to the use of the program. Due to the failure in obtaining permission from the developers a switch had to be made from a school with no prior exposure to a school that has been using *Reading Rocket* for three years. Having an experimental group from one school and a control group from another school would have made any finding invalid because the two groups are not exposed to the same variables such as school environment, teachers and resources. The implication of this lack of a control group is that the main research question could not be answered conclusively, and only a comparison could be made between the program data and the paper-based data.

The second limitation is that the Khanya project is limited to the Western Cape. A Khanya school was chosen because Khanya champions the supply of technological resources to schools who need it most and if *Reading Rocket,* or any other reading comprehension software, proved to be successful, they may be willing to endorse and distribute such software. The implication for this limitation is that the results of only 61 learners in the whole province were used, so the findings cannot of necessity be generalised to the wider South African context.

The main contribution of the study is that the findings suggest *Reading Rocket* to be useful in that it is an objective tool for teachers to use when they want to evaluate learners. Using the program as a

tool for evaluation of literacy skills implies greater validity of the subsequent results, because the computer grades without any human influences.

7.3 Future Research

This study may be expanded by addressing each limitation that was mentioned in the previous section. Researchers may do the same study in all nine provinces in order to determine whether *Reading Rocket* or a similar digital reading program can be used nationally.

If a school with no prior exposure can be found and the learners taught by the same teacher can be divided into a control group and an experimental group, the research question posed in chapter 1 may be answered with more certainty. An ethical concern for this type of study is that the control group would be at a disadvantage if the program is a success, because they would not be exposed to material that could benefit their academic performance.

The same research done in this study can be applied to other reading comprehension programs, for example the *Cami* Reader mentioned in section 5.3.2. Comparing different reading comprehension software with each other may help teachers to make informed decisions about which programs to use.

It is my firm belief that literacy is the foundation of any society and that no person can achieve success without adequate reading comprehension skills. It is a matter of national concern to improve the literacy of all people in South Africa by using all resources available. In this respect, technology is fast becoming the single most influential tool to improve the educational practices of many teachers and enliven the learning of many learners. It is a societal imperative that key players from all spheres of life – educational, economical and political – collaborate in the attempt to improve the literacy levels of all learners.

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Addendum A

Gesprekvoering oor die gebruik van *Reading Rocket*

1. Beskryf asb. die tipe leesprobleme wat deur die leerders by u skool, veral in graad 8, ervaar word.
2. Watter opleiding het u ontvang om *Reading Rocket* te gebruik?

Indien u NIE meer *Reading Rocket* gebruik nie:

1. Hoekom het u opgehou om die program te gebruik?
2. Hoe lank het u dit gebruik voordat u opgehou het?
3. Watter deel van die program het u die meeste gebruik; die Engels of die Afrikaanse lesse?
4. Beskryf asseblief die manier waarop hierdie program gebruik is en hoe gereeld die leerders daarmee gewerk het.
5. Watter ander leesondersteuning ontvang die leerders by u skool?
6. Beskryf asseblief hoe die **gebruik** van die program deur u en Khanya gemonitor is en hoe die leerders se **vordering** gemonitor is.
7. Het u enige verskil aan die leerders se leesbegrip en leesvermoë gemerk?
8. Watter tegnologie is beskikbaar vir taalperiodes. Beskryf wat u gebruik en hoe gereeld u dit gebruik.

Indien u **NOG STEEDS** *Reading Rocket* gebruik

1. Hoe lank gebruik u al hierdie program?
2. Watter lesse word die meeste gebruik; Engels of Afrikaans?
3. Beskryf asseblief hoe die program deel vorm van die leerders se kurrikulum.
4. Beskryf asseblief hoe die **gebruik** van die program deur u en Khanya gemonitor word en hoe die leerders se **vordering** gemonitor is.
5. Hoe word die leerders se leesvaardighede weg van die program getoets?
6. Is daar enige verskil in die leerders se leesvermoë vandat hulle die program begin gebruik het?
7. Watter ander tegnologie word gebruik in die taalklasse?
8. Watter ander leesondersteuning word aan die leerders gebied?