The Scientific Foundations for RocketReader

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Abstract

This paper discusses the research basis for the RocketReader Computer Reading Proficiency software. It describes a foundation based on solid scientific principles and accepted methods of instruction. This paper demonstrates how RocketReader instructional methods tie in to the report of the National Reading Panel 'Teaching Children to Read' and its recommendations, in the areas of reading fluency and comprehension. As a background, this paper discusses how people learn to read, and the biomechanical and neural processes of reading. Unique capabilities of RocketReader are discussed and related to scholarly findings on reading instruction including high comprehension reading, breaking poor reading habits, paced reading, graded reading, inspiration and imagination in reading, and feedback of reading progress. This paper demonstrates that RocketReader is sufficiently grounded in proven and validated reading instructional methods, qualifying schools to receive funding for its purchase, under grants associated with the US federal government Reading First initiative and 'No Child Left Behind' Act.

1 Introduction

1.1 The National Reading Panel

A study of American 8th graders by the US Department of Education in 1998 found that 66% of students were unable to summarize what they read. Although they averaged over 21 hours a week watching television, the time spent reading was less than 2 hours a week. In 1991, 40% of all households did not buy a single book. Such trends fuelled the US Congress in 1997 to establish a National Reading Panel to explore recommendations for effective instructional techniques in reading. This panel comprised 14 people, including leading scientists in reading research, educators, teachers, and parents. This panel distilled the results of 100,000 research studies carried out on reading since 1966 into a comprehensive report. The NRP's report is thought of as the most comprehensive document on reading instruction to date. We refer to these findings as well as the research of other well-established experts in this RocketReader whitepaper.

1.2 The Difference Reading Makes

Children who read well are building a bridge to a successful future. Reading well often translates to reading and learning more, and getting better grades in school, college and university. Children who enjoy reading are often more inclined to read after hours and during the weekend.

Children who read slowly and with difficulty are trapped in another world; the world of the 'slow reader'. They find reading a tiring, difficult and laborious task. As a result, they only read what is absolutely necessary at school and are unlikely to read after hours[2]. In addition, they often have low confidence when reading. Children who fall behind in their reading, fall further behind later on in life. A study by the National Institute of Child Health and Human Development found the majority of children who had reading problems in the third grade continued to have problems in the ninth grade. Children with reading problems often grow up to become adults with reading difficulties[13].

Children who read poorly are often assumed to be lazy. As most teachers know, this is often incorrect. A child who reads slowly and with difficulty is often expending around four times more visual and mental effort to read the same amount of information as a child who reads well. When you put a lot of work into an activity and derive little, tiredness and frustration sets in. These conditions make it very difficult to persevere and improve.

Children are under a lot of pressure. By the second and third grade, they are already expected to read storybooks fluently and comprehend what they read. If a child can see they are not as fluent as their peers, they can quickly become demoralized. This compounds the problem and can perpetuate a never ending cycle of low confidence in reading, and in life.

Hence children often become segregated into two different worlds: the world of the slow reader; and the world of the fast, accurate and high stamina reader[29]. How do we help our children develop good reading skills and build reading confidence so they do not become trapped in the world of the slow reader? How do we transform problem readers into fast and accurate readers? How do we increase fluency and comprehension in slow readers? How do we prepare a child for the future challenges of extensive online and electronic reading[10, 17]?

This article will show how RocketReader techniques, which are based on a solid and conclusive scientific foundation, can address problem reading habits and help develop high levels of reading fluency and comprehension.

2 RocketReader the Company

RocketReader was founded by AI researcher Dr. Simon Ronald in 1996 and in that same year, RocketReader computer software was released. Since then, RocketReader has become a widely used reading proficiency resource around the world, popular with educators, children, students and professionals alike. There are over 22,000 search results for RocketReader on Google (Feb 2005). A search for the keyword 'reading software' on Google reveals the RocketReader web site as the number one ranked result (Feb 2005). RocketReader is used in homes, and in schools, colleges and universities in the USA, UK, Australia and many other countries. The success of RocketReader is underpinned by the following strengths:

1. a broad variety of reading proficiency exercises, working in combination to address a range of reading obstacles

2. great stories and articles, graded and comprehension tested to appeal to a broad range of ages and interests

3. a focus on rapid reading with high comprehension

4. a focus on the elimination of bad reading habits, including vocalization and skip back

5. developed for an international audience; with all texts available in the choice of American English and British English and

pop ups and key dialog instructions available in English, French, German, Italian and Spanish.

6. the user can use their own documents in the various training components, eg. Word, PDF, text, HTML so as to enhance interest and relevance.

3 The Instructional Scope of RocketReader

At this early point it is important to define the scope of operation for the RocketReader reading software. RocketReader does not strive to cover all aspects of the complex process of teaching a student to read. RocketReader does not teach alphabetic skills, phonemic awareness skills and reading out aloud. RocketReader is a specialty reading product that excels in silent independent reading, high comprehension reading skills, and fluency techniques. In particular RocketReader helps break down the bad habits that have been proven to hinder slower readers. RocketReader also focuses on memory development. RocketReader does not train for skimming[11], scanning or other low comprehension reading techniques.

4 An Overview of the RocketReader Instructional Techniques

Figure 1 details the instructional pathways available to the user in the RocketReader software. The user initially logs on with his or her username and password. RocketReader enables users to create their own account, where all their activities are saved. This allows them to track their progress.

The user is then required to choose a lesson plan, which are arranged by session lengths of 10, 20, 40 or 60 minutes. Once a lesson plan is selected, RocketReader will guide the user through a series of exercises specially designed to train the user within the available time. Training exercises are varied so a user who always chooses a short lesson plan will be trained in a variety of different skills over time.

Alternatively, the user can opt for a custom lesson, and create a self-directed session of exercises they would like to focus on.

During the session, users can see the status of three key indicators in the top left hand corner of the main window:

1. *time* — how many minutes the user has been training with RocketReader

2. *effort* — how much effort the user has expended during their RocketReader session; effort is a measure of total progress and is analogous to 'calories burned' on a computer exercise bicycle.

3. *level* — RocketReader has two databases: advanced and basic. The user commences at the basic level and when they have demonstrated a sufficient level of skill[1], RocketReader promotes the user automatically to the advanced mode[2]. Selecting basic or advanced mode affects the level of difficulty of phrases used in flash training, and the texts and comprehension tests used in the skills testing modules.

RocketReader's training exercises are presented in a main skills window. In a predetermined lesson plan, this window will guide the

[1] To be promoted the user must register a high comprehension on a sufficiently difficult reading.

[2] This automatic promotion occurs in the educational version of RocketReader; the non-educational version of RocketReader allows the user to prescribe the basic or advanced levels at will.

user through different exercise components, on the completion of each prescribed component. As explained above, the user can choose which exercise components to complete in a custom lesson. Each exercise component is summarized briefly below.

1. *Flash Training.* This RocketReader exercise involves flashing randomly selected words and phrases of a particular character count very quickly on the screen. The user must then type the flashed text. When they score a certain number of correct answers, the level of difficulty increases. This exercise improves word decoding, fixation width, and helps mitigate the bad habits of eye skip back (regression) and eye overwork.

2. *Grouping Training.* The RocketReader grouping exercises use smart shadows that turn into words. This exercise develops the ability to read chunks of text, as opposed to reading word-by-word.

3. *Speed Training.* The RocketReader speed training involves displaying a single phrase of text at a time on the screen, with the rate of display progressively increasing, training the user to read more quickly. The user can adjust the speed at which the words appear, to a more or less challenging level. This exercise helps mitigate eye skip back and eye overwork.

4. *Practice Readings.* The RocketReader practice readings allow the user to choose from a broad selection of texts on a range of different topics such as science, sport, history and fiction. All practice readings are followed by comprehension tests to ensure reading is accompanied by high comprehension. Font size, colors, text width and text display speed are customizable to user preferences.

5. *Memory Training.* The RocketReader memory tests prepare the user for tests or exams, and help them to learn facts and figures. The user can choose any of the built-in memory tests: in the areas of mathematics, science, SATs, or English; or in any of the hundreds of RocketReader practice readings. Advanced users and teachers can create custom memory tests.

6. *Skills Test.* The RocketReader skills test measures progress on reading speed and comprehension. HTML reports and graphs can be generated to detail the level of progress made. The texts used in the speed tests are carefully selected to be of uniform consistency, so the user receives accurate and appropriate feedback on reading progress.

5 The Process of Reading

Before discussing the scientific support for RocketReader instructional methods, it is relevant to evaluate the various theories on the neural process of reading. Numerous models of reading exist in the scientific literature. These include:

- *Word shape*[4]. The pattern of ascending and descending strokes forms a word boundary. The word is identified by this outline and the context in which it appears. While this model of reading is still popular with some typographers, it is generally considered outdated by most researchers[15]

- *The serial letter recognition model[9].* A model where words are read from left to right, letter by letter in a serial fashion. This was proposed as a simplified model of reading. The process is similar to a word lookup in a dictionary; one locates the first

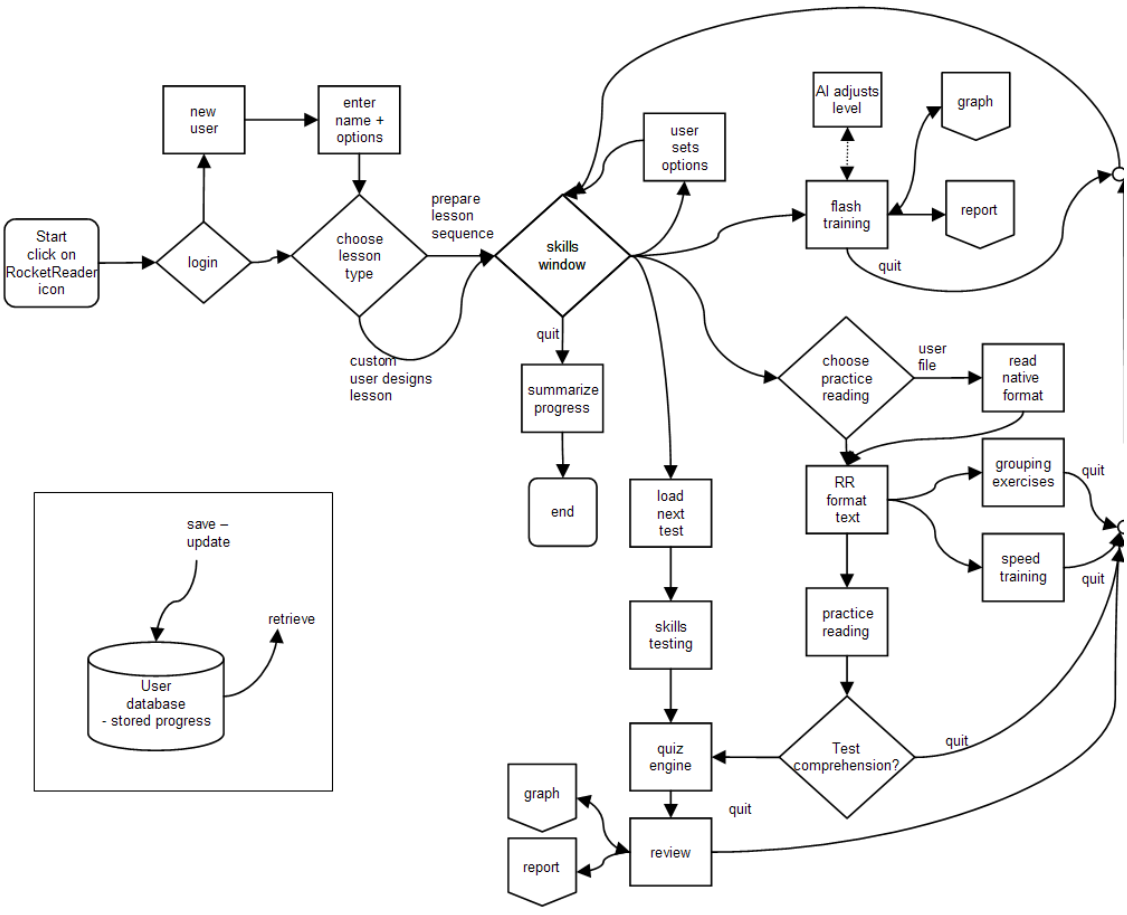

Figure 1: The RocketReader Instructional Process — Simplified Flow Chart

letter and then proceeds to successive letters until the word is located. This model of reading is considered primitive and outdated by most reading researchers.

- *The parallel letter recognition model*[15]. This is the most modern model of reading. This model works as follows[3]. The eyes gaze upon a chunk of text, and the signals reach the brain. Features are then extracted from the lines and shapes. Individual letters are classified in a semi-simultaneous fashion (in parallel). Then the individual letters trigger different neural word classifiers — the word classifier that receives the strongest signal prevails and the word is named. This model describes the letters within the territory of one eye fixation being classified at the same time in parallel by the brain. The labeling of the words occurs as a dynamic process until the strength of the label is sufficiently high. For example, the word *rats* may be prematurely (and partially) labeled during the dynamic parallel letter recognition phase as 'ruts', 'rots', 'rate', 'bats', and 'rats' until the neurons telegraph that 'rats' has the highest signal.

  The parallel model of reading, which has the most scientific support by modern researchers, suggests that we do not read left to right in a letter-by-letter serial fashion. Rather, we look at a chunk of text in a single eye fixation, and each letter in that text is recognized in parallel at the same time until the word or words in the text are fully labeled by the brain. For the slower reader, this process of decoding the words and then associating meaning takes considerable time and effort. This results in reduced speed and comprehension[22].

[3]There are many varieties of the parallel letter recognition model[15]; what follows is a simplified description of one example.

From its inception in 1996, RocketReader was designed with this scientific understanding of the parallel model of reading as its basis. The various exercises, including the flash, speed and group training exercises, train the user to increase text decoding efficiency freeing up more cognitive resources for the reader to absorb meaning[4]. RocketReader's chief training goal is to develop reading speed, comprehension and stamina by training the user to read more efficiently in chunks. First, by increasing the number of letters recognized in a single eye fixation (chunk), and second by increasing the speed at which the information in a single eye fixation is processed. We discuss these in detail below.

6 Critical Reading Skills

6.1 Reading Fluency

Those learning to read often struggle on a word-to-word basis. Reading fluently means reading smoothly and expressively at speeds approaching regular speech[5]. The report of the National Reading Panel found that two instructional approaches working in combination were most effective in developing reading fluency:

1. *Guided repeated oral reading* — This technique is outside the scope of RocketReader's instructional design. It should be noted that teacher or parent led, guided repeated oral reading should be conducted

[4]The importance of meshing word decoding skills with textual understanding and being able to combine both skills effortlessly is discussed in[26]

[5]The speed of regular speech is around 180 words per minute for a regular speaker. The average reading speed is around 200 words per minute for an average reader or 230 words per minute for a college-level reader.

in conjunction with the use of RocketReader to optimize reading development.

2. *Independent silent reading* — RocketReader excels in this instructional technique. Students can choose readings from one of the many topics of interest and select a reading at an appropriate grade level. To facilitate this, all readings are presented in order of increasing difficulty for each category. There is a choice of over 500 graded readings. The wealth of graded reading material promotes extensive reading on a wide variety of topics. Extensive reading practice is a critical component of reading skills development, and has been proven to improve reading speed and comprehension[3]. To demonstrate the breadth of the included RocketReader Readings, the histograms in Figures 2 and 3 show the number of readings that correspond to the RocketReader grade level[6] and the Coleman-Liau grade levels respectively. It can be seen that RocketReader provides an excellent diversity of readings through the spectrum of grade levels, in particular, grade levels three to ten.

6.2 Vocabulary

Vocabulary skills vary widely between people. At the extreme end of capability, William Shakespeare penned 25,000 different words.

[6]The RocketReader grade level is a comprehensive measure of reading difficulty based on number of words per sentence, number of syllables per word, the presence of large words, the absence of very short words, the presence of common English words, the incidence of profanities, the number of sentence clauses, and the use of numbers and symbols. This metric was formulated in 2004 by Dr. Ronald and can be applied to any document using the RocketReader Gold software. The development of this metric is beyond the scope of this paper.

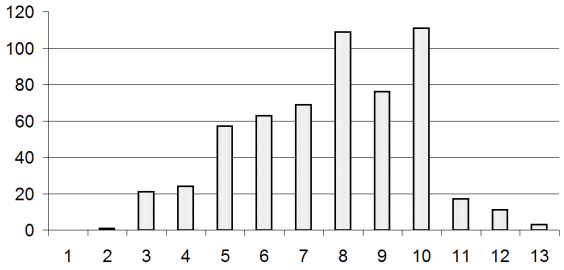

Figure 2: Histogram of the included readings in RocketReader according to RocketReader reading grade level. The Y axis is the number of readings; the X axis is the RocketReader grade level.

However, Shakespeare was exceptionally intelligent, well educated, and had a particular fascination with words. In contrast, the active vocabulary of an average person is a humble 1,000 words. Most people can recognize around 5,000 words.

The importance of vocabulary is well known in the popular culture. Practical tips for improving vocabulary (Google search 'improving vocabulary') include:

1. Installing and using the Concise Oxford dictionary software on your computer.

2. Looking up words conveniently online by using www.dictionary.com and www.thesaurus.com use when writing documents.

3. Using the Microsoft Office thesaurus to vary use of words when creating reports.

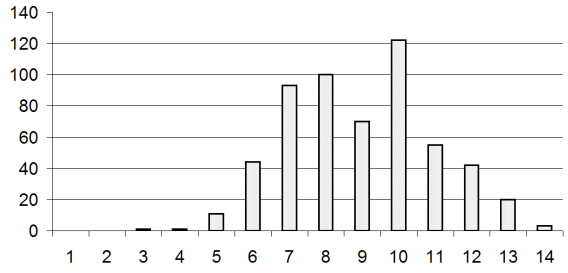

Figure 3: Histogram of the included readings in RocketReader according to the Coleman-Liau reading grade level. The Y axis is the number of readings; the X axis is the Coleman-Liau grade level.

4. Consulting the online encyclopedia at en.wikipedia.org for unfamiliar phrases, words and topics.

5. Having a pocket dictionary on hand at all times.

6. Having a dictionary reference on your desk.

7. Reading more challenging books with a richer vocabulary set.

8. Reading more often.

9. Taking advantage of computer-based vocabulary training.

Many adults have a strong sense their vocabulary can be improved and doing so would have a positive impact on their reading skills. In fact, the notion that vocabulary improvement will aid reading skills actually has a scientific basis. We will now consider the scientific connection between vocabulary proficiency and reading ability.

Studies by Rayner [23, 24] found less frequently appearing words require the eye to fixate on that word for a longer time during the reading process. Typically, less frequent words may take an extra 50 ms per word. Additionally, this delay can slow down the fixation time for the following word — so the interruption has a run-on effect.

These studies measured word frequency by analyzing word counts in a corpus of thousands of books. Such word frequency measurements are thought to approximate typical word familiarity for the average reader. However, Gernsbacher in [8], argues there are fundamental differences between an individual's word familiarity and the frequency with which words appear in a corpus. This means that while a word frequency histogram derived from a set of texts may provide some indication of an average person's vocabulary familiarity, it does not model the vast differences which occur in individual vocabulary knowledge. Discrepancies in individual word knowledge point to a need for better knowledge and familiarity with words, especially less common words. This will enable the reader to cast a wider net over the diverse set of words they are faced with everyday, leading to smaller fixation times and faster reading speeds.

RocketReader can increase familiarity with less commonly occurring words to improve reading skills. This is achieved through the Memory training module in RocketReader, which relies on learning reinforcement to improve vocabulary. In addition, RocketReader's wide range of readings incorporate a rich and diverse vocabulary set, providing indirect vocabulary training.

There is ample research to support the link

between vocabulary skills and its benefit in reading proficiency. As early as the 1940s and 1950s, a series of studies using factor analysis found that vocabulary size was the highest loading factor in reading comprehension ability (Anderson and Peabody). In recent times, the National Reading panel analyzed 20,000 research citations and found that vocabulary instruction led to gains in reading comprehension [20][7]. In their comprehensive 2004 report on vocabulary instructional techniques, the National Reading Panel made a number of key recommendations relating to vocabulary instruction. We discuss how RocketReader performs against each recommendation.

1. *Vocabulary should be taught both directly and indirectly.* RocketReader comprises many graded readings, with each reading accompanied by multiple choice questions. The readings expose students indirectly to a broad vocabulary range, while the comprehension questions facilitate a direct method to learning new words. For the older student, there are hundreds of vocabulary words in the SAT module of RocketReader. These specifically train in a rich variety of vocabulary words and are accompanied by comprehensive vocabulary quizzes in multiple choice format.

2. *Repetition and multiple exposure to vocabulary items are important.* Learning reinforcement and repetition are emphasized in the inherent design of RocketReader's exercises, which focus on high comprehension reading. Users are first exposed to new vocabulary in the context-rich format of readings. The user's understanding of new vocabulary is then tested in the accompanying comprehension tests. In addition, RocketReader maintains and displays a count of how many times a particular reading or quiz has been done. This allows teachers and students to monitor their learning, according to how many repetitions they have done.

3. *Learning in rich contexts is valuable for vocabulary learning.* RocketReader provides a rich vocabulary set within its readings so users are continually exposed to, and learn new words, in context with the story. Learning within rich contexts helps users to reinforce their understanding of a word, as opposed to tediously learning words in isolation. The new words learned while reading are further reinforced through comprehension testing. The carefully selected range of readings also introduce words in their natural context, relating to user's interests and experiences. For example, some readings are geared toward boys aged eight to thirteen, with stories on topics such as skateboarding and dirt biking. Vocabulary procurement is enhanced when learners can relate new words to their own interests and experiences.

4. *Vocabulary tasks should be restructured when necessary.* RocketReader has a flexible authoring facility that allows teachers to create readings with associated comprehension modules. The module is easy to write using a simple mark up language. RocketReader software automatically and interactively delivers this module to the student, scores the result and provides the appropriate student feedback. This enables the teacher to design vocabulary learning tasks and restructure them to student needs. For example, some students may need supplementary vocabulary training in specific areas. The teacher can easily author these on an ad hoc basis

[7] It was noted that the instruction was most fruitful when it matched the age and ability of the reader.

as required. An example of this follows, in which a teacher has prepared a simple text file that contains the specification for a two-word vocabulary exercise:

He was so thirsty that he quaffed his glass of water. Quaff means <choice>.
{*to drink quickly, to spill everywhere, to empty the contents, to evaporate*}

The old man was fooled into buying the sick horse. This means he was <choice>.
{*duped, stifled, vilified, decimated, liquidated, ratified*}

In the above examples, RocketReader will present these two questions to the student as a series of multiple choice questions. RocketReader will present the answers in alphabetical order, and when the student has completed the test, it will display any required corrections[8].

It is easy for the teacher or advanced user to formulate more complex questions that demand that the student experiment with multiple possibilities in order to find the best fitting set of answers. Consider for instance, the following question:

The <choice> king demanded that he <choice> his gaze then <choice> the general with a <choice> of <choice> <choice>.
{*irritable, affable, forlorn, fetid*}
{*avert, cancel, devour, jostle*}
{*abased, ignited, ratified, decimated*}
{*tirade, turnbuckle, travesty, tumescent*}
{*ignoble, fatuous, nebulous, viscous, cous-cous*}
{*profanity, alacrity, melancholy, vim*}

The correct answer is 'The irritable king demanded that he avert his gaze then abased the general with a tirade of ignoble profanity'. To reach the correct answer the user must grapple with what makes sense as well as the word meanings implicit. Although the above exercise shown is somewhat complex, it serves to demonstrate the flexibility of the RocketReader quiz engine. RocketReader's design enables the customization of stories and restructuring of quizzes, to drive an individual's vocabulary procurement needs and enable optimal vocabulary expansion.

5. *Vocabulary learning should entail active engagement in learning tasks.* RocketReader provides interactive learning tasks which actively engage users into learning vocabulary. Its use of multiple choice questions to check understanding, and the review of answers in the correction phase, ensures that users receive valuable feedback on their learning, instantaneously. In addition, users are actively involved in their own learning, with the option to choose readings in their areas of interest and to an appropriate level of difficulty. The user's ability to opt for self-directed learning and monitor their own progress ensures vocabulary learning through RocketReader is interactive and rewarding.

6. *Computer technology can be used to help teach vocabulary.* RocketReader software uses unique computer technology to drive learning outcomes. Its AI-driven operation intelligently ascertains the level of challenge appropriate to users, guiding the user's learning. In addition, RocketReader provides a networked class envi-

[8] In the list of options, the correct answer must appear first so that RocketReader can use the correct answer in the scoring and review phase for the user. RocketReader moves the correct answer into alphabetical order with the other alternatives when presenting the options to the user, so as to provide no obvious clues about the correct answer.

ronment. RocketReader also harnesses computer technology to provide instantaneous, valuable feedback on student progress, to teachers and students. Teachers can conveniently print class and individual reports at a click of a button. Each student's progress is saved under their own login name, so RocketReader can train and appraise student over the longer term.

7. *Vocabulary can be acquired through incidental learning.* RocketReader provides hundreds of readings that expose readers to a vast variety of words, promoting incidental vocabulary learning. These readings are all graded using RocketReader's grading metric to ensure the vocabulary learned at each level is suitable to the user's skill level. For instance, the easiest reading has a RocketReader grade level of one and is called 'When I Grow Up'[9]. The most difficult reading in RocketReader is an excerpt from a 1908 article in the Times newspaper called 'Sleeping Sickness in Uganda' and has a grade level of 13[10].

   Readings are available in a wide range of topics including mathematics, science, SATs, English, history, celebrities, sport and many more. The broad range of available readings ensures users have many opportunities to develop their vocabulary in a wide variety of areas.

8. *Dependence on a single vocabulary instruction method will not result in optimal learning.* RocketReader employs multiple methods for vocabulary improvement. Users develop their vocabulary indirectly by being exposed to a rich and varied word set in RocketReader's database of readings. Vocabulary development is then reinforced through the direct method of specific comprehension questions, to test their understanding of new words.

6.3 High Comprehension Reading

The secret to reading well is the ability to comprehend and extract the appropriate meaning and relevance of what is being read. Comprehension depends on the complexity of the text, and the sophistication of vocabulary. Some texts, like Dr. Seuss's 'Cat in the Hat' are very simple to understand as they contain short sentences, a small average number of letters per word, a small average number of syllables per word, include many common words, and include reading clues such as pictures and rhyme. Other texts, such as 'The American Constitution' are very difficult to comprehend as they contain complex words and long sentences. In the last twenty years, there has been a focus in the business world on simpler language. Legal contracts have become easier to read. Business letters are less elaborate and more direct. Gone are the days where a sentence contains hundreds of words and many compound clauses. These are the days of plain English. Despite this trend, we are faced with the onerous task of having to comprehend piles of notes, books, emails, letters and reports throughout our working lives. Although the format may be simpler, the volume of information we have to digest in these modern times is unprecedented.

Critical readers are aware that often the goal of a written text is to persuade the reader

[9] The first sentence of RocketReader's easiest text is "When I Grow Up I'll be a dancer...a writer...a nurse...or a firefighter."

[10] The first sentence of RocketReader's most difficult text is "We publish this morning an important communication from Mr Hesketh Bell, the Governor of Uganda, containing an account of the terrible ravages of sleeping sickness in that territory, and an appeal to the people of this country for pecuniary assistance toward the alleviation of sufferings which are calculated to excite the most lively compassion in the minds of all who are able to realize either their character or their extent."

to accept the author's point of view on the subject. We should aim to effectively identify, reconstruct and evaluate the author's arguments. This gives us power of knowing that our own opinions are formed as a result of logical reasoning. With critical reading, we can see through manipulative and persuasive writing techniques.

Underpinning RocketReader is a focus on high comprehension reading, which will lead to an enhanced ability to read critically. From RocketReader's comprehension tests, readers quickly learn whether they are extracting the right meaning from the readings. RocketReader meets the two criteria of *comprehension monitoring* and *question answering* in the recommended types of comprehension instruction from the National Reading Panel[20].

7 Breaking Poor Reading Habits

7.1 The Overworked Eye

Reading does not occur when the eyes are moving. Vision transfer occurs when the eyes stop during the fixation phase. The fixation phase of the eye is approximately a quarter of a second for natural reading[12].

Eye overwork occurs when reading a sentence requires excess eye movements and eye fixations. The eyes perform considerable work for little information.

As an example, consider the following sentence

Our biggest expansion opportunity will come from volume licencing in Japan.

A slow reader may move their eyes across the following sentence as follows. Each fixation is represented symbolically by a left and right parenthesis pair.

(our) (big)(gest) (ex)(pan)(sion) (op)(port)(tunity) (will) (come) (from) (vol)(ume) (lic)(en)(cing) (in) (Jap)(an).

This reading example describes 20 eye movements and 20 eye fixations i.e. 40 different eye operations. This considerable eye work is one reason that slow readers get tired. Increased ocular and mental workload often leads to poor comprehension.

Many studies have shown that better readers read the text in bigger chunks - this means fewer eye operations in order to read and understand the same amount of text as compared with a slower reader. A fast reader may read the sentence as shown below:

(our biggest expansion) (opportunity will come) (from volume licensing) (in Japan)

Reading this text takes a proficient reader four eye movements, four eye fixations, and eight eye operations. This is five times less work than a slow reader, requiring much less effort, with better speed and higher comprehension resulting. Faster readers will often have better comprehension because they can read more quickly and details of the sentence remain fresh in their mind. However, slower readers may have forgotten the ideas in the first half of the sentence by the time they read the second half. Hence the slower reader is likely to understand less of what they read.

RocketReader incorporates three exercises that are designed to increase the amount of text the reader can absorb in a single eye fixation. These exercises are the flash, speed and grouping exercises. In addition, the practice readings also have customizable options to enable the reader to read sections of text with one eye movement. Each exercise component builds on the notion of learning to read bigger chunk sizes, faster. We discuss each exercise component in detail:

1. *flash exercises* — the chunk sizes are set according to the measured comprehension of the user at that chunk size - the more accurately the user can read the text, the

more challenging (wider) the chunk sizes become.

2. *grouping exercises* — the chunk sizes are designated by the user, by sliding a slider bar left or right on the interface - smaller or larger chunks result.

3. *speed training exercises* — the chunk size is selected by the user by resizing the window.

4. *practice readings* — the user can control the width of the window and the text will flow around to accommodate this user selection. In this way the user can set a narrow newspaper-like width of just two or three words wide in which an entire line could be read in a single eye fixation.

7.2 Skip Back

During normal reading, the eye moves forward a distance of eight letters during each eye movement. However, this forward movement only occurs nine out of ten times for the average reader. The other ten percent of the time, the eyes skip back or regress to earlier words[12]. This typically occurs for less familiar words or during sentence components that contain semantic ambiguity. Skip back is a significant problem in slower readers. RocketReader Flash and Speed Training exercises are designed to help the reader overcome this habit. These exercises are designed to ensure that earlier read text is not visible to the user. Since there is no material to feed the skip back habit, i.e. nothing to skip back to, this reading problem is quickly unlearned.

7.3 Vocalization

There are two different methods to read words. The first is a direct lookup method where the brain identifies the meaning of the words through a word-recognition process as described in Section 5. The second method is a vocal-assisted lookup where different parts of the word are sounded aloud or silently until the meaning of the word is determined. It has been shown that the average reader often employs a combination of these two methods when reading. Furthermore, it is thought that both mechanisms race together to find the meaning of the word[23].

Vocalization is a widespread reading habit that has the effect of limiting reading speed and comprehension. It occurs when we say the words we are reading out aloud or "under our breath". Verbal sounding of word parts is how many learn to read in the first place, through the application of phonemic awareness skills. A second common reading instructional method involves reading text aloud. This has been shown to be a successful method of reading instruction in conjunction with independent silent reading[20]. Vocalization and reading text out loud may be useful in initially developing basic reading skills, but can be significant habitual obstacles to reading faster. To attain a superior reading speed, it is crucial to master silent reading skills. The proof of this stems from simple mechanics. The average speaking speed is around 180 words per minute. Around 72 muscles must move to produce speech[11]. This is significantly slower than the average reading speed of 230 words per minute, and much slower than a proficient reader who reads accurately at a rapid 500 words per minute. The top speaking speed is around 300 words per minute, but few can maintain the concentration and considerable effort required to speak this quickly. It is clear that one can read faster when reading silently as compared to verbally. A transformation from a talking reader to a silent reader is pivotal in reading

[11] In contrast, throwing a football only requires the movement of around 30 muscles.

faster. Bad reading habits such as vocalization are common in both children and adults and they can be difficult to remove. Many adults, while being literate, have never migrated fully to this next reading stage and often vocalize without realizing it.

A reader who vocalizes has to make a big mechanical reading effort to extract a small amount of information. It is a situation of big effort for poor results. The slow pace of reading and poor level of comprehension resulting can make reading a frustrating, fruitless exercise.

There are many suggested practical strategies to eliminate vocalization[12] including the following tips:

- First of all, be aware of what your lips are doing when you read. If you are saying the words, moving your lips or mumbling through the text, you should make a conscious effort to stop.
- Try and concentrate on concepts, ideas and key words as you are reading.
- Force yourself to read faster — after a while the voice cannot keep up with your reading pace and vocalization will decline.
- Practice these steps two to three times per week for twenty to thirty minutes per session. Do not attempt long sessions over an hour, as this is not conducive to optimal learning.
- Measure your reading speed regularly to keep track of your progress. When testing your reading speed, only read material you have not read before. This is because you will cover material you have previous read at a faster rate, concealing your true reading speed. Set your timer and read for four minutes, then stop. Accurately count the number of words you have read and calculate a words-per-minute measure. In addition, try to get a feel for how well you have read the material — if you can't summarize six major points in the material then it is likely your comprehension was reduced.

Like eye skip back (regression), vocalization is an ingrained habit. Eliminating vocalization requires hard work and dedication but the reward is faster reading and improved comprehension. Many students can make a transition to silent reading, especially with the help of quality teaching and instructional resources. RocketReader employs a number of methods that are designed to assist with this transition to fast and accurate silent reading. These include:

1. *flash training* — this method flashes one or more words on the screen for a very short duration of time, typically 50ms. The student must then correctly type what has appeared on the screen. Further training cycles are then presented, with the number of words being flashed at one time increasing in step with the student's recorded accuracy. The words displayed during flash training are randomly drawn from a large database of 143,330 size-indexed words and phrases. This makes it impossible for the student to rely on their memory to anticipate what will be displayed next. This exercise teaches sight reading as the student does not have time to labor and vocalize through different word components while reading.
2. *Speed Training Exercises* — uses the Rapid Serial Visual Presentation (RSVP) method[16, 5, 28, 6, 27] of paced reading. The sentences in the reading are initially displayed at a comfortable reading speed,

[12] To locate popular self-help references to vocalization one can search on Google for keywords eliminating and vocalization.

then increased in speed during the exercise. At some point the display rate of the text exceeds the pace in which the words can be vocalized. This process breaks reliance on vocalization, teaching the student that comprehension is possible without the act of speaking the words.

8 Speed Reading

Speed reading is a contentious field abundant with unrealistic claims and pseudoscience[30]. On the Internet some sites sell products that claim to teach accurate reading speeds of up to 25,000 words per minute[21]. The MegaReading product developed by Howard S. Berg featured, along with unfeasibly high reading speed claims, in many international feature-length commercials. In 1998, Howard S. Berg was served with a consent order by the United States Federal Trade Commission compelling him to refrain from claiming high-comprehension reading speeds above 800 words per minute.[18]

RocketReader, since its inception in 1996, has always taken the view that an excellent reading speed is in the range of 500 to 800 words per minute and speeds above 800 words per minute quickly degenerate into low comprehension reading or skimming. This view is supported by research into reading speeds.

RocketReader advocates (but does not guarantee or make definite claim) that many people who train sufficiently with RocketReader, can increase their reading speed from an average speed of 230 words per minute up to 500 words per minute, with good reading accuracy and comprehension. This is supported anecdotally by testimonial reports from RocketReader users, for example

> *"I am still surprised at the quick results. Two months just does not seem a long enough to speed up my reading by three times especially considering the material I read is college level. After the first month of use, one hour every day, my reading speed went from 232 wpm to 480 wpm. I hope the result is not atypical; everyone should have the opportunity to enjoy reading more in less time.*
>
> *I recently took up college classes again this fall, and the study time required per class has dropped by almost half. The time I am saving is worth ten times the amount I paid for the program. I now have more time for clubs, volunteering, and the like."*
>
> *(J Riendaeu, Madison WI USA)*

More testimonials can be found at http://www.rocketreader.com/say/say.html.

We have shown that at its core, RocketReader implements many of the recommendations of the National Reading Panel on methods to improve reading proficiency. Its vast database of readings, innovative methods of teaching reading proficiency and focus on high comprehension and vocabulary development are based on established and conclusive research on reading.

9 Inspiration and Imagination

RocketReader provides hundreds of carefully graded readings from basic reading level to adult level proficiency. The readings are designed to cater for the interests and aspirations of various groups, including boys[13] and girls[14].

[13] Boys' readings are packed with action: dirt biking, extreme sports, snowboarding, NASCAR, rap, monster trucks, heavy metal, pro surfing, game fishing, radio controlled cars, dungeons and dragons, baseball cards, Lego design, football sensation David Beckham, and Tony Hawke landing the 900.

[14] Girls' readings include stories about superstars and heroes such as Lisa Simpson, Shakira, Beyonce, Johnny

RocketReader stories are all comprehension tested to check reading progress and understanding. These are all carefully designed with a target audience in mind, to connect with the user's interests. The following excerpt from a reading about skateboarding in RocketReader illustrates the careful selection and monitoring which underpins the design and authoring of each story. Firstly, the target audience for this story titled 'Johnny and the Boys' Extreme Skateboarding Adventure' is boys aged from eight years of age. It has an ARI rating of 3.0, and a Wheeler Smith rating of 3.6. It has a RocketReader grade level of 4.8. What is distinctive about this story is that it makes use of jargon which is easily recognizable and widely used by this target audience, such as 'wiped out', 'dude', 'kickturn', and 'fakie'. It taps into the common interests of the target audience, with subjects which include choppers, motorcycles, skateboards, competition and tricks. Learning is enhanced when it is situated in a context which a person can relate to. It is this philosophy which drives the design of readings and comprehension tests in RocketReader. RocketReader aims to make reading fun, enjoyable and relevant to a user's experience, so they are motivated and inspired to learn and read. The excerpt follows:

> Being a kid from San Francisco, I learned to skateboard when I was four years old. Most of my friends are the same way. Every afternoon after school, we go down to the Embarcadero, the hot skate spot in the city.
>
> "Johnny, you got any new moves?" The question came from my best friend, Mark. Mark was wearing baggy shorts and an oversized Orange Country Choppers T-shirt. He was also really into motorcycles.
>
> I went up the ramp and did a kickturn.
>
> "That's not new," Mark said, seeming disappointed.
>
> "I haven't practiced any new moves lately. What do you have?" I challenged.
>
> Mark was up for the challenge. He got in a natural stance and started off up the ramp. He turned and rode backward in a fakie and then turned again. When he got to the top of the ramp, he jumped, and his skateboard balanced on the edge. He then rode the edge and jumped the nine feet down. He didn't have a really smooth landing, but he picked himself up.
>
> "What did you think?" he asked.
>
> "That looks hard. I don't know if I want to jump down all that way," I replied.
>
> "Dude, it's only nine feet. It's nothing," he baited me.
>
> Unable to resist the challenge, I tried to repeat what he'd done. I couldn't maintain my balance, though, and slipped off before I had a chance to skate off the ledge. I heard laughter behind me.
>
> "Dude, you totally wiped out," said my friend Mike. Apparently, the whole gang was there to witness my fall.
>
> "Well, you try it then. It's not as easy as it looks," I challenged Mike.
>
> The other guys egged him on, and before long, we were all taking turns wiping out on the ledge. Surprisingly, no one had to go to the hospital!

Another example of reading is 'The Vacation

Depp and Usher. New multi-part adventure stories are included about school girls who set out together on various trips to the Big Apple, a boat cruise and other exciting adventures.

House' which is aimed at girls for ages eight plus. The story describes a group of school girls that go to work at a bed and breakfast during their school vacation. Following is an excerpt.

> "I'm kinda scared," Amanda said.
>
> "I've never cooked before either, but Granny said we need to know how to do everything in case we ever need to do it," I answered.
>
> "It's not that bad. She shows you how to do everything step by step," Nell encouraged us.
>
> "What if we mess up dinner?" Amanda asked.
>
> "Granny's going to help us. She isn't going to turn us loose," Nell laughed.
>
> Just then Granny flounced in like a twenty-year-old.
>
> "Okay, girls, did everyone wash their hands?" Granny asked, cheerful as ever.
>
> "Yes," we all replied.
>
> "We're going to make lobster a la Martin. That's my own recipe," Granny said with a laugh.
>
> I was shocked to learn that the lobsters were live! I didn't know that we'd have to put them in the boiling water. "Otherwise they let out a poison," Granny explained.
>
> We got the water boiling and then Granny said, "Okay, grab a lobster."
>
> "We have to put them in?" I asked, horrified.
>
> "How else are they going to get in?" Granny smiled.
>
> Hesitantly, we all grabbed a lobster and tossed it into the huge pot of boiling water. This was the hardest part. Then Granny set us to work on mixing a sauce for the lobster and peeling potatoes.
>
> "We're going to add the potatoes in a minute," Granny said.
>
> After some frantic boiling, Granny pulled the lobsters out of the pot and set them into a larger pan. Then we added the sauce Amanda and I had mixed. Nell fished out the potatoes and set them around the lobsters.
>
> "Oh, the bread. Let's get that in the oven. Can one of you pre-heat the oven please?" Granny asked.
>
> "How do I do that?" I asked.
>
> Granny laughed and walked to the stove. "Just turn this button. When the timer goes off, put the bread in."
>
> We found the butter sauce and garlic. "This is going to go on the bread with this brush," Granny explained.
>
> When we got done, the meal was beautiful. It looked fit for a king. "Where did you learn how to do this?" Amanda asked.
>
> "Oh, here and there," Granny answered elusively and carried the lobster platter into the dining room.

10 Reading Disorders

Research has consistently shown that people with reading disorders such as dyslexia, Meares-lrlen Syndrome and visual impairment can benefit from specifically designed reading tuition, guided reading and lesson plans.

Reading disorders, such as Dyslexia and Meares-lrlen (Scotopic Sensitivity) Syndrome, affect a significant number of people. Dyslexia is the most common cause of reading difficulty; it is estimated that one in 10 children is dyslexic.

Being affected by a reading disorder can be a daunting and frustrating experience for a child and, if not properly addressed, might lead to low self-esteem and underachievement in adult life. At the same time, children with dyslexia are often characterized by above average intelligence, and can excel if given proper attention and assistance. History is full of examples of many noteworthy people who have overcome dyslexia to achieve enormous success — George Washington and Albert Einstein being probably the most famous. Those with reading disorders may suffer from low reading stamina and slow reading speeds. In one study of dyslexic undergraduates it was found that more than half could only sustain reading for five minutes or less before becoming too tired to continue[1].

Research has consistently shown that people with reading disorders can benefit from specifically designed reading tuition and improve their reading skills and ability to process information at any age. For example, the study by Klassen in [14] showed that dyslexic students who received special reading support made up 6 months per year in additional reading progress with 13% of the students with reading disorders catching up to their peers. However, the earlier the problem is diagnosed and addressed, the better the chances of successfully overcoming it. According to the International Dyslexia Association, 74% of the children who are poor readers in third grade, remain poor readers in the ninth grade. This means they never make the transition to proficient readers in adulthood.

Fortunately, more and more research is being conducted into the field, and some proven methods of instruction and techniques that are effective in overcoming reading disorders have emerged. RocketReader software uses the following special features and techniques to make reading instruction easier for dyslexics and others affected by reading difficulties:

10.0.1 Choice of special preset exercise templates.

The user can control the appearance of the RocketReader exercise windows by picking from a selection of visual templates that automatically set the font colors, type face and spacing. The templates have been especially designed for users with various reading difficulties, such as dyslexia, ADD/ADHD, and visually impaired readers (as per the English Royal National Institute for the Blind's recommendations).

10.0.2 Custom colored texts and backgrounds.

In addition to choosing from a variety of templates, RocketReader allows the user to pick from a palette of contrasting colors, or even set custom colors. It is now a well known — and researched — fact that people with reading difficulties often find using colored eyeglasses and tinted contact lenses assists their reading. (Meares, O. 1980, Irlen, H. 1983, Wilkins AJ, 1993). The use of colored overlays — sheets of translucent or transparent colored plastic placed over a page — has also proven beneficial[25].

10.0.3 Wide selection of fonts.

The user can change fonts in all RocketReader exercises, and in the popup dialogs. The user can also select the line spacing e.g. 1.5 spacing or double line spacing.

Individuals with poor reading speed and reading difficulties, often have problems with the letter recognition process; specifically, the ability to detect the vertical strokes or edges that make up the characters. According to Irons, P. (2003), text size should be at least 12 point and preferably with increased character spacing, as these additional elements have

been shown to reduce some of the visual disturbances which occur.

10.0.4 Displaying a limited number of words at a time.

The RocketReader flash, grouping and speed training exercises all use the principle of displaying a limited number of words (starting at the most basic level with one word) at a time. In combination with the ability to control speeds, the user is given total control over the pace of the exercises. This enables users to exercise 'as fast as they can but as slow as they need to', which is consistent with the principles of the Orton-Gillingham approach[19].

10.0.5 Training to better detect word boundaries.

Some recent research by Florer and Hunter-Khan [7] suggests that changes in reading rate that result from letter spacing are attributable to the detection of word boundaries, and not the visibility of letters. RocketReader flash and grouping exercises train the reader's eye to better distinguish word boundaries, thus improving the fluency of reading.

10.0.6 Readability analysis

RocketReader allows the reader to determine the grade level of the texts read, thus ensuring that practice is performed on texts of adequate complexity.

10.0.7 Comprehension testing.

Poor comprehension is a known problem associated with reading disorders. RocketReader's dedicated comprehension tests are designed to ensure that an increase in reading speed is accompanied by excellent comprehension rates.

10.0.8 Structured Exercises.

RocketReader's structured, sequenced, repetitive exercising environment is consistent with the Orton-Gillingham approach. Other benefits include a rich selection of practice readings targeted at various age groups (age six to professional level), lesson statistics for teachers and parents, customizable look and feel, and many more features to address reading disorders.

11 Conclusion and Future Research

This paper has established the importance of reading skills and its lifelong impact on confidence and success in education and the workplace. It introduced the history of RocketReader and explained the scientific model of reading on which RocketReader is mainly based; namely, the parallel model of letter recognition. It also examined the key areas of reading instruction which RocketReader excels in, and how critical reading skills can be gained and poor reading habits eliminated. In addition, the article shows how RocketReader can help improve the reading skills of those with reading disorders.

In sum, this paper demonstrates how RocketReader instructional techniques are grounded in solid and conclusive research on reading which spans many decades. Much of RocketReader's scientific foundation is based on the recommendations of the National Reading Panel on methods to improve reading proficiency. This paper also details other research on which RocketReader's principles rely upon.

It is clear becoming a better reader is a two pronged process, contingent on solid instructional techniques, and considerable training and practice. RocketReader has solid instructional techniques based on proven tech-

niques and solid research. It also facilitates extensive reading practice, having been formulated to be suitable for both home use and use in educational settings. RocketReader can help transform reading into an enjoyable and productive task, opening the way to significant improvements in educational outcomes, career prospects and participation in life.

12 About the Author

Simon Ronald, CEO, is the Chief Architect of RocketReader.

Dr Ronald has a PhD in Computer Science (Artificial Intelligence) from the University of South Australia and a Bachelor of Engineering in Digital Systems and Computer Engineering from the Royal Melbourne Institute of Technology (evolutionary and genetic algorithms) and is co-author of two patents.

Dr. Ronald is an advocate of reading proficiency because of his own personal experiences in education and the workplace. Dr Ronald has analyzed many reading and speed reading programs, books, CDs and tutorials. He understands the problems which hold people back from becoming skilled readers, having discussed these problems with many RocketReader users.

Combining his expertise in A.I. and interest in reading improvement, Dr Ronald designed RocketReader computer software in 1996. He also developed the RocketReader speed reading seminars which have been well received by corporate audiences internationally, in countries such as the USA, Kuwait and Australia.

He has been recognized for his vision for innovation. In 2003 he was awarded the prestigious SA Pearcey Award for 'Innovation and pioneering achievements and contribution to research and development in Information Technology.' In 1981 he received an Australian Young Inventor Award and appeared on the ABC's 'The Inventors' program.

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