

An Investigation into evaluating the effectiveness of Reading Assisted Software aimed at children who have Dyslexia.

Honours Project Final Report

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‘Except where explicitly stated all work in this document is my own’

Signed:

Abstract

For children with dyslexia adapting to the classroom culture and becoming accustomed to the curriculum to which they are assigned to can be a demoralizing experience as reading fluency, accuracy and comprehension can be significantly inferior compared to other pupils of the same age. Furthermore recent statistics have shown that dyslexia is a condition that affects at least one of every ten children in the UK. Reading Assisted Software would appear to be an obvious choice for supporting dyslexic children with their reading. However there is much debate as to the overall effectiveness of such software. This paper reports a small-scale experimentally based study that investigated whether the intervention of Reading Assisted Software aimed at children with dyslexia aged 8-13 years of age could facilitate reading accuracy, comprehension and fluency of 8 dyslexic children (mean age 9.9 years) who were significantly disadvantaged in literacy skills. The Reading Assisted Software intervention over a 4-week period presented some fascinating results. Significant gains were made in the children's reading fluency, however there was no major improvement in their reading accuracy and comprehension, as the children showed similar performance in their results from pre-to post-test. One very noticeable conclusion from the results was that the children demonstrated higher levels of enthusiasm and motivation from using the Reading Assisted Software. The results also suggested that the Reading Assisted Software support could be easily worked into existing teaching and learning strategies held in schools as the children could work independently with the software during school lessons.

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1. Introduction

As children progress through school they are expected to adapt to the classroom culture and become accustomed to the curriculum to which they are assigned. For children with dyslexia this can be a demoralizing experience as reading fluency, accuracy and comprehension can be significantly inferior compared to other pupils of the same age.

There are a number of definitions of Dyslexia. The International Dyslexia Association(2006) defines Dyslexia as a neurologically based, disorder that interferes with the acquisition and processing of language. It is manifested by difficulties with 'accurate and /or fluent word recognition and by poor spelling and decoding abilities.' Dimitriadi (2001) continues that Dyslexia with its connotation 'lexis' implies that this disorder is manifested with difficulties in reading. Should a child have the condition Dyslexia then the term 'Development Dyslexia' is often used (Coltheart et al., 1994; Tijms et al., 1995). As mentioned above, a person with Dyslexia often has problems associated with reading.

Furthermore dyslexia is a condition which astonishingly affects at least one of every ten children in the UK (British Dyslexia Association, 2006) and according to the National Institute of Health in the USA (2006, cited in Dore, 2006) is the leading cause of reading failure and school dropouts in the USA

Reading Assisted Software such as Talking Books Software would appear to be an obvious choice for supporting children with dyslexia. The introduction of such Reading Assisted Software has given Dyslexic children the opportunity to approach information and develop their reading skills in a variety of ways with the assistance of a familiar medium that correlates with their own interests e.g. computer games. Talking Books Software replicate real books but have the ability to pronounce words, phrases and sentences through computer generation. Reading Assisted Software for the aforementioned reasons has now been incorporated into many classrooms around the UK and abroad (Cole et al, 1999).

1.1 Background

Rather surprisingly there is much ambiguity and variation between research results indicating whether Reading Assisted Software is more effective as opposed to more conventional methods of learning, reading traditional text presentation within a book for example.

Several studies have indicated that Reading Assisted Software could be specifically used to aid dyslectics in improving their reading. Goldstein et al's study (2006) aimed to investigate the effectiveness of 'Pre-Codia,' a novel computerised reading aid for people suffering from Dyslexia. The study was targeted specifically at demonstrating whether there would be a significant improvement in subjects reading ability using the reading aid compared to what there would be when simply reading text on paper. All subjects were Dyslexic children with a mean age of 15. The study highlighted that text was read significantly slower with 'Pre-Codia' than with paper and there was relatively small differences between reading on paper and using 'Pre-Codia' in terms

of reading comprehension. However the children favoured Pre-Codia as it had higher subjective ratings in terms of perceived difficulty and perceived effort.

Another similar study by Tijms et al (2003) evaluated a Reading Assisted program that is assumed to be an efficient and effective training tool for children with dyslexia. The study determined that through usage of the software, children showed significant improvement with their reading, however the improvements were not substantial enough to compare the subjects to the reading ability of non-dyslexic users at the same age. Indeed other studies continue to present findings of improvements in the reading ability of dyslexic children through usage of Reading Assisted Software. Lynch et al's (2000) study examined the effectiveness of a computer based literacy system in secondary school with two different groups, dyslexic children and non-dyslexic children. The study concluded that both different groups showed sign of improvement in reading, however the program proved to be more effective for the non-dyslexic children. Lynch et al's findings perhaps indicating that Reading Assisted Software application should be commonly practiced with non-dyslexic users, as improvements in reading ability are greater than dyslexic users could be expected to achieve.

However, in most cases the evidence presented does not support their advantage over more traditional methods of learning still used within many classrooms today. Mathew (1997) in an extensive experimental study investigated whether CD-ROM storybooks are necessarily better than traditional print storybooks. The study concluded that overall the reading comprehension scores were statistically equivalent between the two groups of third grade children who had being assigned to either using the CD-ROM storybooks or traditional print storybooks. Although this study was not targeted at dyslexic children it did however highlight the fact that more conventional methods of learning e.g. reading text from paper, should not be overlooked simply because of they may be not be aesthetically pleasing compared to the multimedia rich environment embedded in many of the 'Talking Book' programs today.

Singleton (2001) in a wider scale questionnaire based survey investigation of the utility of 'WordShark', a multi sensory computer program designed to improve children's reading and spelling ability, noted that one of the main advantages of using Reading Assisted Software is that it allocates the teachers more free time to focus on other teaching matters. This finding signifies that in what was already a stretched resource, teaching can essentially become more efficient as the teacher has more free time to attend to other concerning matters.

Therefore these conflicting findings suggest that it would be useful to know whether Reading Assisted Software intervention would prove to be effective in improving a Dyslexic child's reading ability.

1.2 Project Outline and Research Question

This project is an experimentally based evaluation type of project. The project will be a collaboration of a literature review, to build the foundation upon which the project will be constructed, and an experiments which will be conducted within an appropriate test environment before and after the test subjects i.e. dyslexic children aged 8 – 13 years of age, have used the Reading Assisted Software.

These experiments are designed to measure the reading ability/performance of the test subjects pre-test and post-test so that judgement can be made to the overall effectiveness of the software. The implementation of these experiments was a significant area of this project, so that in order to determine a conclusion as to whether Reading Assisted Software is effective in improving the subjects reading ability. Essentially Dyslexic children tend to have reading related problems associated with reading accuracy, comprehension and fluency (Fawcett, 2004). Therefore the research question will try to address this problem and hence the research question being: does Reading Assisted Software aimed at children with Dyslexia (aged 8-13) facilitate reading accuracy, fluency and comprehension?

In order to address my main research question, sub-topics/issues relating to the project area have to be tackled. The sub questions of my main research question are as follows and will influence my literature review.

- What is the typical existing teaching method/s for improving the reading skills of dyslexic children? The software used within the experiment will need to enhance the existing teaching methods used in the classroom environment when teaching dyslectics to read. Thus means that existing teaching methods and their characteristics need to be identified along with a discussion on how they are used to aid the learning of reading within the target group.
- To what extent has these techniques been adopted (successfully or otherwise) in reading assisted software aimed at Dyslexic children? The types of software that has been used in assisting Dyslexic users with reading (successfully or otherwise) needs to be discussed as this will provide particular techniques which may be used within the software or how these techniques may be adapted to a real life situation.
- How can the reading ability of Dyslexic children be “measured”? It is important to identify an appropriate method of measuring the reading ability of the target group before and after so that essentially the experiment is realistic and sound judgements as to whether reading accuracy, fluency and comprehension were improved or not can be made.
- What is an appropriate test environment to allow Dyslexic children to use Reading Assisted Software to help improve their reading ability? So that a valid evaluation can be made to the effectiveness of the Reading Assisted Software used within the experiment an appropriate test environment has to be identified, hence there is a requirement to consider other similar studies and identify the environment in which they conducted their research.

The aim of the project is to evaluate the hypothesis that Reading Assisted Software will provide improvements in the subjects’ reading ability in terms of accuracy, fluency and comprehension. Thus the project’s intention was to select an appropriate piece of Reading Assisted Software, put it in a realistic experiment using children of that age under the supervision of the teacher and measure using established measures of reading ability such as the Neale Analysis of Reading Ability as this provides an effective and popular way of capturing the accuracy, fluency and comprehension of reading by comparing pre-test and post-test data. (Neale, 1997)

A semi-structured interview with the children performed at post experiment stage will capture subjective usability data relating to the children's experience of the selected Reading Assisted Software and will identify how usable the children found the Reading Assisted Software because this will be important to any wider scale usage of this software and if the software is not very useable it can negate the actual quality of the software's internal content and additionally this user-based evaluation will also provide valuable feedback as to the learner satisfaction from the software.

A target group of eight children all of whom have the syndrome Dyslexia were selected and all are already well familiar with traditional text based presented methods. The target group's teacher is familiar with their reading abilities and can provide expert judgements regarding their reading abilities. The teacher will be consulted post experiment stage to provide an expert evaluation in the form of a pedagogical evaluation report regarding the pedagogical impact of the Reading Assisted Software, which will not necessarily be derived from the two other previously mentioned methods i.e. the semi-structured interview and the Neale Analysis of Reading Ability formal tests.

1.2.1 Rationale

Teachers often do not have the time to make correct judgements that are required for selecting good software for their pupils, as they do not have the opportunity to rigorously test the software comprehensively. Instead packaging of the product can persuade teachers' judgment. The output of this project could be very useful for teachers allowing them to make more valued selections in software in future for this target domain.

Another beneficiary of the outcome of this project may be the software developers' themselves, because not only to they strive to make the software as usable as possible but essentially their main intention is to improve the target user's performance in the specified academic domain e.g. reading. Furthermore Quinn (1996) suggests that the developer's main objective should be in producing software that is "usable and educational." The project outcome will also inform developers as to whether or not the users' reading ability was improved.

1.3 Report Structure

Essentially the report is structured by having the report sections outlined below.

1.3.1 Literature Review

The Literature Review, detailed in section 2, essentially provides a foundation and understanding of existing teaching methods and their characteristics for teaching the target group of users, and also details the application of computer-assisted techniques. Evaluation methods and their characteristics are also discussed within this chapter, so that an understanding of appropriate methods for the purposes of this investigation is established.

1.3.2 Methods

The Methods used to evaluate the effectiveness of the Reading Assisted Software are explained within section 3 of the report. The primary research method, in this experimentally based project, is stated and justified as to why this method was selected to investigate whether Reading Assisted Software would be effective in improving the reading ability of the target group.

The Methods chapter also includes a detailed outline of the precise nature of the intended experiment, including an explanation and justification of its configuration to be used within the investigation. As this is an experimentally based evaluation project that involves human subjects an additional explanation of why the target group, dyslexic children (aged 8-13), were considered appropriate to act as evaluators for the demonstrating the effectiveness of the Reading Assisted Software and any limitations this selection may impose on the ability to generalise.

1.3.3 Results

The results of the primary research method are presented within chapter 4. One of the interesting features of this chapter is the analysis and evaluation of the reading performance data of the subject's of this investigation, which was collected at both pre-test and post-test stage. A detailed presentation of the results obtained from the user based evaluation and expert based evaluation is also presented, analysed and discussed within this chapter. In particular the results of the aforementioned methods detailed in chapter 3 are discussed, and potential reasons for the findings obtained within the project, and what they mean in terms of the precise nature of this investigation is also presented in this chapter.

1.3.4 Conclusions

The primary objective of the Conclusions chapter detailed in section 5 of the report is to draw together the detail of the presented points and individual conclusions from the previous Results chapter. Specifically the results discussed are from the primary research method i.e. Neale Analysis of Reading Ability, results from the user based evaluation and expert based evaluation are also discussed within this chapter.

This chapter also presents a brief summary of the work undertaken throughout the project course, an indication of further work that could be conducted within the future related to this projects and its outcome and detail the final conclusions drawn from the project.

2. Literature Review

A review of literature pertaining to the effectiveness of existing Reading Assisted Software in improving the reading ability of the user target group than traditional text presented on paper will provide a foundation and understanding of existing teaching methods and their characteristics used in the teaching of dyslexic children by Special Education Needs teachers today. Likewise Application of computer-assisted techniques will be identified and discussed, analysing various examples of how the existing teaching methods have been adopted or adapted into reading assisted software successfully or otherwise.

In addition to this another area discussed within the context of this chapter is Evaluation methods and their characteristics are to be discussed so that an understanding is achieved of useful method to use during experimental stage of the evaluation project.

2.1 Typical Existing Teaching Methods

The selection of suitable Reading Assisted Software for the project is dependant on establishing what exactly the reading ability problems associated with dyslectics are and what the typical existing teaching methods for improving the reading skills of dyslexic children are.

2.1.1 Reading Ability Problems

Extensive research has evolved as to what is the reasoning for dyslectics having profoundly poorer reading abilities than people who do not have the syndrome called dyslexia still often referred to as “word blindness” despite this term being coined in the 19th century by Dr. A. Kussmaul (Guardiola, 2001). Shankweiler et al. (1995) investigation into what skills constituted to be a successful reader suggested that good phonological awareness skills was the strongest single factor that correlated to this success and Dyslexics in contrast had significant weaknesses in phonological processing, the ability to identify and decode sounding from syllables inside word constitutes to poor reading ability (Wise, 2002). Indeed poor phonological processing ability is the single most contributing factor to dyslectics having poor reading accuracy, fluency and comprehension. (Richard & Torgesson, 1987)

Considerable research has evolved regarding dyslectics and their poor ability to comprehend what they have read. Reading Comprehension is “an interaction between reader and text by which meaning is created” (McNeil, 1984) and tends to be a skill in which many dyslectics are profoundly weak in due to their tendency to comprehend a text which in actual fact is completely different from the actual text (Gregor et al., 2003). Mathew (1996) in an extensive study into whether or not Reading Assisted Software improved the users comprehension and attitude compared to conventional methods such as text presentation found that there was no significant improvement in the users comprehension. Mathew’s findings are perhaps typical of Gregor et al’s conclusion that dyslectics lack the ability to comprehend what they have just read.

Other studies have identified reading fluency being a significant factor relating to poor reading ability of dyslectics. Fawcett (2004) determines reading fluency as

having the ability to reiterate words more and more quickly without conscious thought. Goldstein et al. (2006) identified in an investigation into the effectiveness of 'Pre-Codia' Reading Assisted Software compared to traditional text reading of paper that Dyslectics read significantly slower with 'Pre-Codia' than with paper. Furthermore research has indicated that Dyslectics have difficulties with the accuracy of their reading. Brunswick et al (1999) reported that Dyslectics were significantly weaker than non-dyslexics in reading accuracy and by adding pseudo-words to text reading accuracy can be improved. Brunswick et al's findings further demonstrate the problems Dyslectics encounter when reading text.

The above findings draw attention to the fact that there are key reading ability problems for dyslectics when faced with reading information and in particular suggest the importance of identifying good existing teaching methods, which are used by Special Education Needs teachers today in assisting dyslectics with their reading. Although teachers may be restricted in dealing with deficits that a dyslectic pupil may have they can however help the dyslectic by utilising a number of different teaching methods.

2.1.2 Phonological Awareness Skills

Phonological Awareness skills are regarded as being an extremely efficient method in the development of reading for any child to learn let alone a child with dyslexia (Gibbs, 2005). Exercises in Phonological Awareness allow the child to hear the letter sound, which makes up the word through syllables associated with the word. (Wise et al., 2004) The typical teaching method, which is used in teaching children with dyslexia, is Phonological Awareness Skills. (Adams, 1990; Goswami, 1999) The emphasis on Dyslexic children being taught this method at school is significant. (Snowling, 1995). Furthermore the teaching of phonological awareness skills is thought to be a solid and established way of reading instruction, which is equally important to accuracy, fluency and comprehension. (National Reading Panel, 2002)

A considerable amount of research in the study of phonological awareness in relation to improving dyslectics improve their reading ability, such so this has been reflected in the development of teaching materials such as the Phonological Awareness Programme (Willson, 1993). Wise et al (1999) in an extensive qualitative study using different methods of teaching for improving dyslectics reading ability found that although phonological awareness training was an established method of teaching reading, the emphasis should be on embedding the phonological awareness training within an appropriate level of textual information to provide an approach to reading that was more balanced and structured. Therefore when a teacher utilizes phonological awareness skills method of teaching, an appropriate level of textual content should be used as poorer readers such as dyslectics rely on context more than good readers do. (Nation & Snowling, 1998).

2.1.3 Syntactic Awareness

The majority of research within this field has focused on developing reading skills with respect to phonological awareness skills as it relates to the development of fluency in reading. (Kame'enui & Simmons, 2001). However in relation to improving children's reading comprehension, a teaching method called Syntactic awareness is

commonly used as it is an effective method in learning words (Ehri & Wilce, 1980). Bentin, Deutsch, & Liberman (1990) indicate that Syntactic Awareness can be developed in a variety of tasks including grammatical judgment, sentence correction and oral cloze. A grammatical judgment task involves the dyslectic either orally hearing or viewing a sentence in writing and then signifying which sentences are correct and incorrect in terms of grammatical structure. Whereas a sentence correction task involves the dyslectic being presented with a grammatical sentence which is incorrect and therefore must correct the best form. An oral cloze task simply involves the dyslectic hearing the sentence with a missing word and then must present the sentence in a grammatical form that is correct.

2.1.4 Building Self Esteem

Dyslectics particularly dyslexic children often experience failure and suffer frustration coupled with the feeling of being inferior to other children, thus means that some dyslectics may have a low self esteem. (Bingham, 1980) Therefore when teaching dyslexic children the emphasis on building the child's self esteem should be significant. Humphrey (2003) explains that the role of the teacher first and foremost is to build self-confidence in pupils with dyslexia. Humphrey continues that by marking work submitted by the dyslexic child positively, always encouraging and avoiding negative criticism will build self-esteem. The importance of evaluating suitable software to see whether this method is adopted is therefore significant.

2.1.5 Developing Working Memory Skills

Dyslectics tend to have poor memory skills and as a result their reading performance particularly reading comprehension suffers. (Singleton, 2003) Memory of the dyslectics can be improved through a teaching method called Working Memory Skills, thus allowing them to have better reading comprehension. (Baddeley, 1986). Furthermore Siegel (1994) suggests that Working Memory is critical to the reading process as the reader not only must have the ability to recognize and decode words but should also be able to remember what they have just read. Indeed several studies relate to the importance of dyslectics and children with poor reading abilities receiving tuition from their teachers in developing their working memory skills Da Fontoura and Siegel (1995) aimed to investigate the differences in reading skills including working memory skills between Portuguese children learning English as a second language and native English speaking children. The study found that the working memory skills of dyslectics were significantly poorer to that of average readers. Thus highlighting the need for supporting dyslectics in their reading through usage of working memory skills teaching method within the classroom.

The above findings suggested within this section of the literature review regarding the typical teaching methods used in improving the reading ability of dyslectics highlight the fact that Phonological Awareness Skills, Syntactic Awareness, Building Self Esteem, and Developing Working Memory are all extremely popular and established teaching methods used in improving dyslexic children and poor readers reading ability. Thus suggests that the selection of suitable software, to be used within the experimental stage of this project, should be evaluated as to whether this teaching method is embedded within the software in some way.

2.1.6 Reading Ability Tests

The purpose of the above teaching methods is to improve the subjects reading ability, there are standard measurements of reading ability. Studies directly investigating reading ability of people with dyslexia are controversial in terms of methods and results. (Singleton, 2003) The Neale Analysis of Reading Ability provides an effective and popular way of capturing the accuracy, fluency and comprehension due to it having parallel forms it is particularly useful for providing a true comparison of pre-test and post-test performance. (Neale, 1997) Johnston et al's study (1999) aimed to investigate the use of their Multi Sensory Programme for Reading. The study highlighted that the programme, used by teachers when trying to improve dyslectics pupils reading ability, was successful in doing so and it also improved self-esteem. Open-ended questions and story re-telling are said to provide a truer reflection of reading comprehension ability in a user than standardized tests. Tierney (1992, cited in Mathew, 1996, p382). These findings identify the Neale analysis of Reading Ability as the main established way of measuring reading ability of dyslexic children and thus advocates use within this project.

2.2 Application of computer-assisted techniques

This section will discuss the application of computer-assisted techniques in the development of reading, and identify and discuss particular examples analysing how the existing teaching methods have been adopted or adapted into reading assisted software successfully or otherwise.

2.2.1 Evolution of computer-assisted Technologies

Historically computer assisted technology has being associated with people of disabilities, however this conception is rather naive as it does not acknowledge the fact that people with learning difficulty syndromes such as dyslexia can benefit from such assistance. (Andersson & Draffan, 2005) Despite this conception, the use of computer-assisted technology, as a way of improving children's education has exploded in recent years. Clark (1994) suggests this is the result of children being stimulated by material presented on computers. In more recent times computer-assisted technologies have being adapted for those with specific learning needs such as dyslexia. Technologies such as speech synthesis, originally designed for visually impaired people, and speech recognition, originally designed for business people have all being adapted so that dyslectics may have the benefit of using them. (Andersson & Draffan, 2005) Speech Synthesis is an important and useful technology found in many Reading Assisted Software packages. (Olson and Wise, 1992). The above discussion indicates how computer assisted technology has evolved and been adapted to current day technology that use a variety of techniques that aid dyslectics with learning.

2.2.2 Application of RAS adoption of Existing Teaching Methods

This section will identify several studies that have investigated Reading Assisted Software's ability in improving reading ability and whether or not these studies have

adopted the existing teaching methods, identified previously, successfully or otherwise will be discussed.

There have been a number investigating the use of Reading Assisted Software to aid reading development in children. Thomson (1984) discusses several advantages of using Reading Assisted Software to aid a dyslexic child in reading, notably these are: that Reading Assisted Software provides encouragement and immediate feedback to the user, the user controls the pace of learning and the program is non judgemental. The advantages identified above suggest that through Reading Assisted Software the self esteem of a dyslexic child can be built, thus highlighting the adoption of existing teaching methods namely building self esteem is adopted by Reading Assisted Software programs. These beliefs are widely shared by many today that computers have capabilities of engaging and encouraging users by vividly presenting activities through high-resolution displays and complex graphics. (Cole et al, 1999).

Furthermore several studies have investigated Reading Assisted Software, which has adapted existing teaching methods used to improve dyslexic children and other poor readers, successfully or otherwise. Chera (2003) in a study aimed to demonstrate talking books' ability to promote phonological awareness skills in children learning to read. This study highlighted that phonological awareness activities such as reading text whilst simultaneously hearing an oral representation within the Talking Book software can enhance a child who is learning to read improve phonological awareness skills. A similar study by Tijms et al (2003) evaluated a Reading Assisted program that is assumed to be an efficient and effective training tool for children with dyslexia. The study found that Working Memory Skills and Syntactic Awareness Skills had been developed as the children had learned how to read repeatedly flashing words from the computer screen while simultaneously listening to the word being orally spoken. Evidently the findings from both these studies indicate the extent at which existing teaching methods such as Working Memory Skills and Syntactic Awareness Skills have been adopted within Reading Assisted Software. Furthermore Malone (1981) suggests that when children experience new technology they become more motivated and this builds self-esteem. This suggestion highlights how building the child's self esteem, another existing teaching method, can be utilised within Reading Assisted Software.

A number of Reading Assisted Software Developers have focused on developing the users reading ability by implementing the phonological awareness teaching method into the software. Foster et al (1994) in an extensive study evaluated two pieces of Reading Assisted Software, 'Daisy Quest' and 'Daisy Castle', both packages provided phonological activities for pre school aged children. The study found that the children had made considerable improvements in their phonological awareness skills thus an important aspect of learning how to read. In a similar study by Torgesson and Barker (1995) using the same Reading Assisted Software programs but a different sample of children aged 5-6 years old found reported significant improvements in word reading skills after using the Reading Assisted Software programs. Furthermore Mithchel and Fox (2001) in a comparable study to Foster et al (1994) concluded that phonological awareness skills were improved when children used both the 'Daisy Quest' and 'Daisy Castle' programs. Indeed these findings have demonstrated that teaching methods such as developing phonological awareness skills can be successfully adapted within Reading Assisted Software.

Reading Assisted Software programs frequently utilise Speech Synthesis, should a user experience difficulties in reading a word then the Speech Synthesis facility is selected so that the user may listen to the word orally expressed. Olson & Wise (1992) in an extensive study into the effectiveness of speech synthesis, found that word comprehension in children was improved through speech feedback, the study however indicated that children with syndromes such as dyslexia were better advised to couple phonological awareness training with speech feedback rather than being exposed to speech feedback alone. This finding highlights the importance phonological awareness training has to improving dyslexic children's reading ability and thus the research indicates that the inclusion of phonological awareness activities should be the basis of any Reading Assisted Software program. (Lynch et al, 2000) Figure 1 is an example of a Phonological Awareness activity with a Reading Assisted Software application.



Figure 1: Example of Phonological Skills Task in RAS (Stansfield, 2005)

2.2.3 Successful or Otherwise Application of RAS

Several studies have demonstrated the application of Reading Assisted Software and its effectiveness. Goldstein et al's study (2006) is an evaluative study aimed to investigate 'Pre-Codia', a novel computerised reading aid for people suffering from Dyslexia and its ability to improve the reading accuracy, fluency and comprehension of dyslexic children of a similar age to the subjects of this project compared to reading text on paper. The study found that that text was read significantly faster (12 wpm faster) with paper than with 'Pre-Codia' and there were relatively small differences between reading on paper and using 'Pre-Codia' in terms of reading comprehension. The study measured fluency by timing the subjects reading passages from the screen

and paper. However the value of the study's results can be challenged as subjects were given an inappropriate time of 5 minutes, to be familiarised with the Reading Assisted Software. This suggests the method of measuring users reading fluency is invalid. Lynch (2000) in a similar study but using a smaller sample of users, all of whom were described as having poor reading abilities, used Reading Assisted Software over a ten-week period before being tested. This study used the 'Neale Analysis of Reading Ability' to measure reading accuracy, fluency and comprehension and noted that all subjects made gains in either reading fluency and/or comprehension. The conflicting findings from these two studies suggest that there are key implications to consider when establishing a suitable test environment and conditions such as the test subject gaining familiarity with the software before usage is critical and selection of appropriate ways of measuring the reading ability of the subjects is another aspect to be considered.

Wood's Study (2005) aimed to investigate whether Reading Assisted Software namely phonic based 'talking book' software can outperform a conventional way of teaching such as traditional reading tuition from an adult to children who are in the beginning stages of learning to read. The study analysed difference between pre-test and post-test data by measuring reading ability of two groups of children, one group solely using the 'talking book' software and the other group having one to one tuition from their teacher, with a revised method of the Neale Analysis Reading Ability Test. The study reported that although the Reading Assisted Software did not outperform the one to one tuition from the adult, there were no significant differences between the two different groups in terms of phonological awareness attainment. However further use of this method of measuring reading ability suggest that the Neale Analysis of Reading would be an effective way of measuring the reading ability of dyslexic children, hence it also being such a popular measuring method within this discipline. (Neale, 1997)

Mathew's study (1996) aimed to investigate the effectiveness of 'talking book' software on improving the readers' comprehension and attitude compared to that of print versions of the storybooks. This study highlighted the need for a controlled experiment environment, as measurements for two different groups need to be analysed. This study found that the users of the 'talking book' software showed better comprehension scores (+0.50) than those who used the print versions of the storybooks. The study highlighted the relevance that methods for measuring the reading ability of the subjects such as open-ended questions and story retelling had. Furthermore adopting such methods provides a true reflection of the subjects' reading comprehension thus allowing a more valid outcome to the hypothesis to be evaluated against. Tierney (1992, cited in Mathew, 1996, p382) indicates the importance of utilizing methods like open-ended questions, "If we continue to measure the effectiveness of technology with standardized tests, we'll never see technology's true value to education."

2.3 Overview of Literature

The objectives of the literature review were to provide a foundation and understanding of existing teaching methods and their characteristics used in the teaching of dyslexic children by Special Education Needs teachers today, discuss the application of computer-assisted techniques and the way in which Reading assisted

software has successfully or otherwise adopted the existing teaching methods and characteristics. The review also highlights several studies similar with a similar hypothesis to this project. Perhaps the most significant conclusions that can be drawn from the review of literature is that developing phonological awareness is an area in which there has been substantial research into when developing the reading ability of children with dyslexia, and hence this being the reason why Reading Assisted Software has focussed on this aspect more so than any other existing teaching method.

3. Methods

This section describes the methods used to evaluate the effectiveness of the Reading Assisted Software. The primary research method in this experimentally based project, is stated and justified as to why this method was selected to investigate whether Reading Assisted Software would be effective in improving the reading ability of the target group whom are already familiar with conventional learning methods such as reading traditional text presented on paper. A detailed outline of the precise nature of the intended experiment is given, including an explanation and justification of its configuration to be used within the investigation. As this is an experimentally based evaluation project that involves human subjects an additional explanation of why the target group i.e. dyslexic children (aged 8-13), were considered appropriate to act as evaluators for the demonstrating the effectiveness of the Reading Assisted Software and any limitations this selection may impose on the ability to generalise.

3.1 Primary Research Method

This project is an experimentally based evaluation project. The type of primary research method used is an experiment where a selected piece of Reading Assisted Software will be used in a realistic environment over a period of time and evaluate its impact. This is a useful technique that has been used in a variety of areas and has actually been used in several studies demonstrating the effectiveness of Reading Assisted Software in improving the reading ability of children with dyslexia. Goldstein et al (2006) in an experimental evaluation investigated demonstrated that children with dyslexia's reading ability could be significantly improved. Furthermore Olson & Wise (1992) adopted this technique by carrying out a similar experimentally based evaluation investigation into the effectiveness of Reading Assisted Software.

Similar studies have shown that this type of experiment to be conducted over a series of a number of weeks. Mathew (1996) suggests that subjects work with a researcher for one hour a week for up to 4 weeks. Whereas Lynch et al. (2000) suggests that subjects work in accordance with two researcher within the classroom for a period of ten weeks for an unspecified amount of time per week. Research has shown that the most commonly used method of establishing a more valued outcome related to the hypothesis is by obtaining quantitative data before and after the experiment regarding the subjects reading ability. (Goldstein et al., 2006; Wood, 2005)

3.1.1 Selection of Reading Assisted Software

In this particular case a suitable piece of Reading Assisted Software needed to be selected using the characteristics of successful pieces of Reading Assisted Software identified in my literature review. There were several pieces of Reading Assisted Software that were successful in improving users reading ability available e.g. Daisy Quest and Daisy Castle were both highlighted in my literature review as both these applications had improved users reading ability. The key characteristics of them were developing phonological awareness within the user and thus building self-esteem (Mitchell & Fox, 2001). However the software selected was 'The Mystery of the Lost Letters' as it had adopted some of the key aspects of existing teaching methods highlighted within the literature review, these key aspects discussed how developing phonological awareness skills, working memory skills, syntactic awareness, and

building self esteem in dyslexic children were the basis of improving their reading ability. (Nation & Snowling, 1998; Kame'enui & Simmons, 2001; Siegel, 1994; Humphrey, 2003) Thomson (1984) concluded that in order to build self-esteem in a child, it was fundamental that encouragement and positive feedback were provided at any opportunity. 'Mystery of the Lost Letters' applied Thomson's principles of build self-esteem of the users by encouraging and providing positive feedback, see Figure 2, and additionally had activities, which focused on developing the users phonological awareness skills thus being an significant aspect of learning how to read (Goswami, 1999).

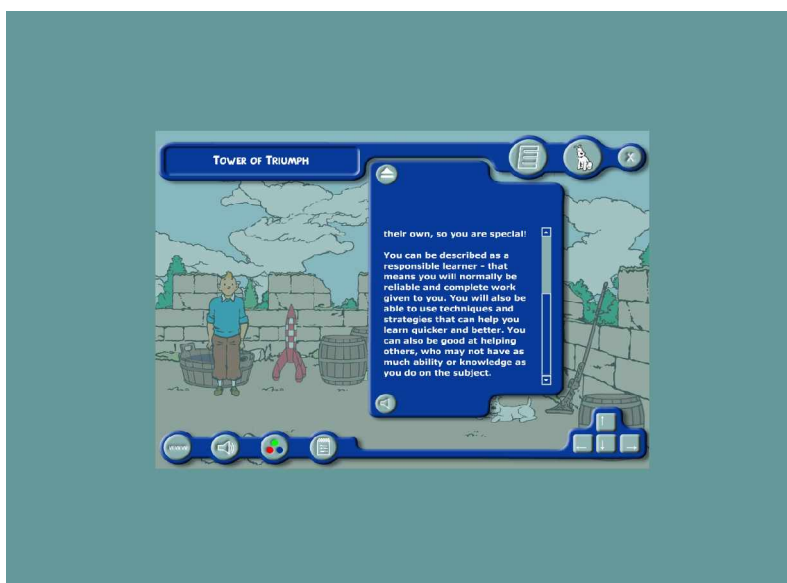


Figure 2: Example of 'Mystery of the Lost Letters' providing user with positive feedback.

3.2 Outline of the Specific Nature of Experiments

The experimentally based evaluation involved the participation of a school from the Western Isles that do not wish to be named within the context of this report; therefore this school shall be referred to as School X. Through a personal contact it was possible to arrange for School X to participate within this experimentally based evaluation project. School X is a fairly large primary school with approximately 400 pupils and has the main learning support facility within the Western Isles. Therefore pupils from both primary and secondary pupils from other schools within the area with special learning needs such as dyslexia attend School X. Learning Support Teachers within School X utilise existing teaching methods such as developing phonological awareness skills and other methods, which are detailed in the literature review, when assisting the dyslexics with their reading. Therefore it would be useful to try and investigate whether Reading Assisted Software aimed at children with Dyslexia (aged 8-13) facilitate reading accuracy, fluency and comprehension..

The application of this experiment will involve the participation of a sample of eight pupils from School X aged between 8 and 13 years of age, that have the syndrome dyslexia. These subjects who will remain anonymous throughout the report are an appropriate target group for the purposes of this experimentally based evaluation,

as they have the necessary conditions required to evaluate the project's hypothesis i.e. they have dyslexia and require assistance from the teacher to support them with their reading, they are within the age group, and are already well familiar with traditional text based presented methods and the member of staff in charge is familiar with their reading abilities to provide expert judgements regarding their reading abilities. The target group have the necessary criteria to act as "evaluators" within this experiment. However this sample is focused on children aged between 8-13 and have dyslexia, and is focused on a particular selection of Reading Assisted Software this may prohibit my ability to generalise on the effectiveness of other selections of Reading Assisted Software in improving reading ability of children that have dyslexia.

There were two phases of the experiment, involved in the duration of the project timescale, these were pre-test and post test. Literature Review has suggested that the most commonly used method of establishing a more valued outcome related to the hypothesis is by obtaining quantitative data before and after the experiment regarding the subjects reading ability. (Goldstein et al., 2006; Wood, 2005) The duration of the experiment was 4 weeks, with the subjects using the reading assisted software with assistance from the teacher for two thirty minute sessions a week. This involved the subjects using the software in groups of two at a time due to the limitations of computer systems being available. It should be noted that a conditions of the experiment was that subjects received no additional form of reading tutoring from their teacher for the duration of the experiment. This ensures that the results of the experiment were more valid as they purely reflect the effectiveness of the Reading Assisted Software intervention. Conclusions from the literature review suggested that subjects work with a researcher for one hour a week for up to 4 weeks. (Mathew, 1996) However the presence of a researcher being present is not feasible but this is not problematic as the teacher can simply replace the researchers presence and can then provide a pedagogical evaluation afterwards to report any observations that may have been noticed. Literature review also highlights that the subjects should be familiarised with the software before they commenced on an experimentally based evaluation. (Goldstein et al., 2006) Therefore the subjects including the teacher became well familiarised with the Reading Assisted Software that they were to use through a demonstration regarding its layout, functions etc., before they participated within the experimentally based evaluation.

The methodology of this project is composed of three different evaluation methods, these being:

- NARA II Neale Analysis of Reading Ability
 - (Formal Tests performed at Pre-test and Post-test stage)
- User Based Evaluation
 - (Semi-structured Interview performed at Post-test stage)
- Pedagogical Expert Evaluation Report
 - (Pedagogical Impact of the RAS conducted at Post-test stage)

3.2.1 NARA II Neale Analysis of Reading Ability formal tests

The collaborative technique which was used to determine the effectiveness of the Reading Assisted Software in improving the subjects reading accuracy, comprehension and reading fluency is the NARA II Neale Analysis of Reading Ability: Revised. This technique was identified and discussed in the literature review and is an appropriate way of measuring reading accuracy, fluency and comprehension, thus due to it having parallel forms it is particularly useful for providing a true comparison of pre-test and post-test performance. (Neale, 1997) The NARA II Neale Analysis of Reading Ability is a formal test aimed for use with pupils aged 6 – 12 years 11 months, and involves the children reading a short story from a book which comprises 6 short stories that increase in reading difficulty levels. The children are encouraged to read as much of the story as possible. It is the assessors responsibility to correct the child when needed whilst simultaneously noting and categorizing the errors made by the child i.e. mispronunciation, substitution, refusal, addition, omission and reversal.

The reading accuracy score of a child was determined from the amount of errors noted by the test administrator i.e. the teacher, when the child was reading the short passages of text aloud. The NARA II Neale Analysis of Reading Ability test also provides a measure of reading comprehension. After reading each short passage of text, each child was asked questions relating to what they had just read, this assessed their understanding of the text. These questions required either a literal understanding of the text or an inference to be made. One point is awarded for each correct answer given by the child. During the administration of each test, the time taken to read each passage is recorded in seconds. The total number of words the child has read is then divided by the total time of reading and multiplied by 60 to discover the rate/ fluency of reading raw score.

NARA II Neale Analysis of Reading Ability is particularly useful as it provides a standardized score summary for each test subjects Accuracy, Comprehension and Rate raw score in which reading Accuracy, Comprehension and Rate are all represented in the form of Reading Age, Standardized Score and a National Percentile Rank, which are very practical indications of the child's reading level. For the purposes of this study children were encouraged only to attempt the stories as to what the teacher felt was appropriate to the child's ability. Form 1 of the NARA II Neale Analysis of Reading Ability was used at pre-test stage and Form 2 was used at post-test stage. Pupils were tested using this method in a quiet and comfortable corner of a classroom of School X, where distractions and interruptions were kept to a minimum. This added more validity to the results obtained. Pupils were put at ease before experiment by stressing that it was not them that were being tested as such but it was the effectiveness of the Reading Assisted Software, which was being tested. It was important that the children were familiar with the structure of the assessment and knew what to expect (Hill et al, 2005). Therefore each child participated in a practice test beforehand, in which they read a sample passage and were asked questions afterwards. Thus ensuring further validity of the results obtained. It should be noted that two different sample passages were used before proper conduction of testing at both pre-test and post-test stages. The hypothesis will then be determined by measuring the critical variable of the amount of improvement recorded in each test subject's results gathered by applying the NARA II Neale Analysis of Reading

Ability for each subject from pre-test to post-test.

3.2.2 User Based Evaluation

In addition to evaluating “hard” measures like subjects reading comprehension and fluency performance scores it is extremely useful to identify how useable the children, the users of the software found the software to be. The subjective usability of the software will be significant to any wider scale usage of this software and if the software is not very useable it can negate the actual quality of the software’s internal content (Nielson, 1993). Further to identifying how useable the children found the software it would be worthwhile investigating the users’ subjective feelings of satisfaction or frustration after using the software. Granic et al. (2004) in an evaluative study of a web based educational system points that software may very well be useable but it is of little benefit to the user should the user avoid it simply because they find it frustrating. Therefore users subjective feelings of the software should be found within this investigation as it may correlate to the overall effectiveness of the Reading Assisted Software in improving the users’ reading ability.

Gena (2005) comments that a user-based evaluation is a standard HCI technique; the user-based evaluation will be conducted in the form of a semi-structured interview at post experiment stage, an efficient method of obtaining data about the subjects’ views regarding the software. Jankowicz (2000) indicates that semi-structured interviews are the most advantageous approach when attempting to obtain data when the evaluator knows sufficient about the aims and the main questions to pose during the evaluation. Jankowicz’s indications give good reason for using a semi-structured interview at post experiment stage as away of obtaining data about the subjects’ views regarding the software

The semi-structured interview used within the investigation consists of several different types of question. Easterby-Smith et al (2002) recommends the use of open-ended questions within semi-structured interviews as this avoids bias on the interviewer’s part. Therefore some questions to be asked during interview need to allow the interviewee i.e. the child, a degree of freedom to express their viewpoints regarding the software and not feel obligated to provide an answer that they think the interviewer wants to hear, by doing this a fuller and more accurate account of how useable the children felt features of the software were can be gathered from the interview. Questions asked in the semi-structured interview were partly based on the IBM Computer Usability Satisfaction Questionnaire (Lewis, J, 1995). Some questions within the semi-structured interview are designed to capture the users experience of the Reading Assisted Software; more specifically open-ended questions asked were related to how useable particular features of the software were to the child. Whereas other questions asked within the structured interview compromised of rating scales for the child to provide their ratings of the software; this is recorded using a five-point Likert scale. The Likert rating scale is one of the most effective methods of collecting opinion data (Dillman, 2000). The subjects indicate their level of agreement to a statement on the five-point Likert scale. By applying a combination of open-ended questions and Likert scale type questions within the semi-structured interview, see Figure 3, the results of this method provides an effective indicator as to the level of users subjective satisfaction with the software’s interface, ease of use and overall

satisfaction with the software. The results of this evaluation will not only be useful to software developers looking to develop new educational software but also to the teachers thinking about selecting a piece of Reading Assisted Software to be used in by the pupils.

For each word below, please indicate how well it describes the software:

Annoying	Disagree	1 2 3 4 5	Agree
Confusing	Disagree	1 2 3 4 5	Agree
Frustrating	Disagree	1 2 3 4 5	Agree
Interesting	Disagree	1 2 3 4 5	Agree
Easy to use	Disagree	1 2 3 4 5	Agree
Fun	Disagree	1 2 3 4 5	Agree

2) Was it difficult to move Tintin around the game?

Comments:

3) How often did you need to use the text to speech feedback facility?

Never 1 2 3 4 5 All the time

Comments:

4) What aspect of the software did you enjoy most?

Comments:

5) What aspect of the software didn't you enjoy?

Comments:

6) Would you use 'The Mystery of the Lost Letters again?

Comments:

Figure 3: Predetermined Questions asked in Semi-Structured Interview with the children.

Furthermore a study carried out by Lahikainen et al (1991) determines that a major drawback to interviewing children within groups was that other children influence the answers of individual responses, and that individual interviews were far more reliable and less vulnerable. On the basis of Lahikainen et al's findings the children were interviewed individually so that their answers to the pre determined questions asked within the semi-structured interview were as reliable as possible. Data was collected via a semi-structured interview in accordance with the MRS guidelines (MRS, 2006) for interviewing children. The class teacher accompanied all children during the

interview. Due to the nature of the interviewees' capabilities and in accordance with the MRS guidelines for interviewing children the number of questions asked within interview had to be limited to six questions, thus ensured that unfair demands on their capabilities were not made during interview. Before the interview commenced the children were asked for their honest thoughts regarding the software. This was done so that the children were encouraged to express their opinion without reserve (Druin et.al, 1999).

3.2.3 Pedagogical Impact of RAS Evaluation

Should a teacher's application of the Reading Assisted Software be as an additional tool for teaching then although usability of the software is paramount, so is the need for the software to satisfy other criteria such as pedagogical objectives (Silius et al, 2003). Therefore it is important to evaluate the pedagogical impact of the Reading Assisted Software.

The third and final collaborative technique used was a pedagogical expert evaluation of the Reading Assisted Software. The children's teacher, considered an expert in the field of Learning Support, was asked to observe any changes in the children's behaviour, and usage of the software. The teacher performed this evaluation at post experiment stage so that an overview of the pedagogical impact the software had on the children would be drawn. The term 'pedagogical usability' (Silius et al, 2003) may be more appropriate to this evaluation method in some respects as the teacher in the post experiment pedagogical expert evaluation report will distinguish whether the particular features of the software i.e. tools, content and tasks were useful in providing support to the children during the experiment in an educational context. A study by Silius et al (2003) concluded that pedagogical usability evaluations of software was an important method of establishing whether the software learning environment supported the children according to their selected pedagogical objectives. The results achieved from this method will be a valuable indicator to the pedagogical impact the software had on the children, which will not necessarily be derived from the two other previously mentioned methods i.e. the user based evaluation and the Neale Analysis of Reading Ability formal tests.

3.3 Overview of Methods

The objective of the Methods chapter was to draw from the conclusions made in the literature review and outline and describe this projects primary research instrument and detail the specific nature of the experiments. Essentially this project will be an experimentally based evaluation project. The type of primary research method used is an experiment where dyslexic children will use Reading Assisted Software aged 8-13 in a school classroom environment over a period of time and evaluate its impact in improving the children's' reading ability.

Three Methods will be used to evaluate its impact. The collaborative technique which was used to determine the effectiveness of the Reading Assisted Software in improving the subjects reading comprehension and reading fluency is the NARA II Neale Analysis of Reading Ability: Revised. A semi-structured interview was another method used to evaluate the usability of the software and identify the children's subjective feelings towards the software. The results of this evaluation will not only

be useful to software developers looking to develop new educational software but also to the teachers thinking about selecting a piece of Reading Assisted Software to be used in by the pupils. Finally a Pedagogical Expert Evaluation Report will assess the pedagogical impact of the Reading Assisted Software.

An analysis of all the results of the above-mentioned methods shall determine whether the Reading Assisted Software was effective in improving the reading ability of the subjects of this study and identify which characteristics of the Reading Assisted Software were effective or not in doing so.

4. Results

Within this chapter of the report a detailed presentation of the results obtained from the NARA II Neale Analysis of Reading Ability formal tests, user based evaluation and Pedagogical Expert Evaluation Report are presented, analysed and discussed. In particular the results of the aforementioned methods detailed in chapter 3 will be discussed, and potential reasons for the findings obtained within the project, and what they mean in terms of the precise nature of this investigation shall be presented.

All subjects performed well in experiment evaluation methods, as there were no difficulties in understanding what to do or how to do participate. The presentation of the results of the evaluation methods is detailed below.

4.1 NARA II Neale Analysis of Reading Ability Results.

The section will present and discuss the results obtained from the NARA II Neale Analysis of Reading Ability formal tests. As mentioned in the methods chapter of this report the NARA II Neale Analysis of Reading Ability is an appropriate way of measuring reading accuracy, fluency and comprehension, thus due to it having parallel forms it is particularly useful for providing a true comparison of pre-test and post-test performance in reading. In order to interpret the children's performance on the test scores it was necessary to find their standardized scores. Having tested the children and calculated their raw score for Accuracy, Comprehension and Fluency they were then converted to their standardized scores i.e. Reading Age, Standardized Score and Percentile Rank. Standardized Scores enable comparisons of child's performance in the Accuracy, Comprehension and Fluency tests to be made with a large, nationally representative sample of children aged 6 years to 12 and 11 months. Thus providing a more useful measure than raw scores as it places pupils' scores on a readily understandable scale.

Reading Age scores are the age at which the raw score was the average in the large, nationally representative sample of children aged 6 years to 12 and 11 months. They provide a useful indicator to the child's current level of reading attainment. Standardized Score provides another way of representing a child's raw score into a standard age score. This score is obtained by finding the intersection of a child's actual age and raw score in the conversion tables for Accuracy, Comprehension and Fluency. Percentile Ranks allow a child's performance to be very clearly with the national standardization sample. The Percentile Rank is essentially the performance of pupils in the sample of the same age who gained a score at the same level or below that of the child's score. Results from the NARA II Neale Analysis of Reading Ability have also been converted into Mean scores for ease of comparison with collective performance of the children at pre-test and post-test stage.

Due to the primary purpose of this method i.e. measuring reading accuracy, fluency and comprehension, this section has been structured with subsections, which represent these 3 elements of reading. By focusing on each element separately a more clear representation of the results can be drawn out.

4.1.1 Reading Accuracy Results

Table 1 summarises the pre-test and post-test reading accuracy performance of the test subjects i.e. the 8 children with dyslexia, when using the NARA II Neale Analysis of Reading Ability. By applying the reading accuracy performance results data of each child into tabular form, constructive comparisons could be made both individually for each child and collectively as a group.

Table 1: Reading Accuracy pre-test and post-test scores by children

	Age at Testing		Reading Age		Raw Score		Standardized Score		National Percentile Rank	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Pupil A	9.06	9.06	7.01	7.01	29	27	81	80	11	9
Pupil B	10.06	10.07	7.09	7.10	38	37	84	82	14	12
Pupil C	9.04	9.04	7.09	7.09	38	36	88	90	22	26
Pupil D	8.08	8.09	6.01-	6.01-	9	10	70-	N/A	1	1
Pupil E	11.01	11.02	10.08	10.08	70	70	98	98	45	45
Pupil F	12.05	12.06	11.07	11.07	77	78	98	96	45	40
Pupil G	10.01	10.02	7.07	7.07	36	34	84	83	14	13
Pupil H	10.02	10.02	8.03	8.03	44	42	88	88	22	22
Mean	9.91	9.92	7.18	7.18	42.63	41.75	77.63	77.13	21.75	21

The mean age of the group of children used within the experiment was 9.91 years at pre-test stage, however the groups' mean Reading Age in terms of reading accuracy at the same stage of experiment was 7.18 years. This is a point worthy of mention as it highlights the fact that collectively as a group the children's level of reading pre-test was nearly 3 years (-2.73) below the reading attainment expected corresponding to the actual age at which they were at. The fact that these children were below the reading attainment expected of pupils of the age at which they were at, is rather unsurprising as this fact was highlighted in the literature review, that dyslexic children are profoundly weaker than non dyslexic children in their reading accuracy (Brunswick et al, 1999). Note that 'Pupil D' performed below the floor of standard scores on some tests, for example the NARA II Neale Analysis of Reading Ability standard score floor is 70 and children narrowly failing to achieve this level of performance were awarded 70- or N/A if they did not come anywhere near. However 'Pupil D' was the youngest tested in this experiment, 8.08 years old at pre-test stage, this may be a significant factor in why this pupil's performance was considerably poorer than the other subjects of the experiment.

The main point of discussion regarding the results displayed in Table 1 however is the fact that collectively there was no sign of improvement in reading accuracy

performance at post-test stage as the group's mean score of Reading Age stayed at 7.18 years. Despite the groups mean score, individually only 'Pupil B' showed sign of improvement in reading accuracy, improving from a Reading Age of 7.09 at pre-test stage to a Reading Age of 7.10 at post-test stage. It should also be noted that although 'Pupil C' narrowly missed out on improving in terms of Reading Age, 'Pupil C' was the only child to improve upon the Standardized Score achieved at pre-test by +2 and as a result achieved an increase of 4% in National Percentile Rank. 'Pupil C's' improved National Percentile Rank score of 26, recorded at post-test stage, indicates that 'Pupil C' performed as well as, or better than 26 per cent of the sample, having taken 'Pupil C's' age of 9.04 years into account. These findings, compelling as they may be indicate that in terms of the Reading Assisted Software facilitating an improvement in reading accuracy, pretty insignificant gains in terms of Reading Age were made. However Table 1 highlights that no child worsened with its reading accuracy performance in terms of Reading Age, which therefore is perhaps supportive to the application of the Reading Assisted Software should it be used for a greater length of time for example.

Another advantage of using the NARA II Neale Analysis of Reading Ability it provides a way of recording and categorizing the type of error made when the children are reading the short passage of text. The children's errors were recorded at pre-test and post-test stage and categorized into each type of error. Figure 4 summarises the overall amount of errors that occurred at pre-test stage for the group of children. Similarly Figure 5 summarises the individual types of errors made by the children at pre-test stage. The number of errors made by the child during reading the short passages of text has an overall effect on the reading accuracy raw score of the child. Therefore it would be useful to delve further into the types of error made at pre test stage and post-test stage both individually and collectively.

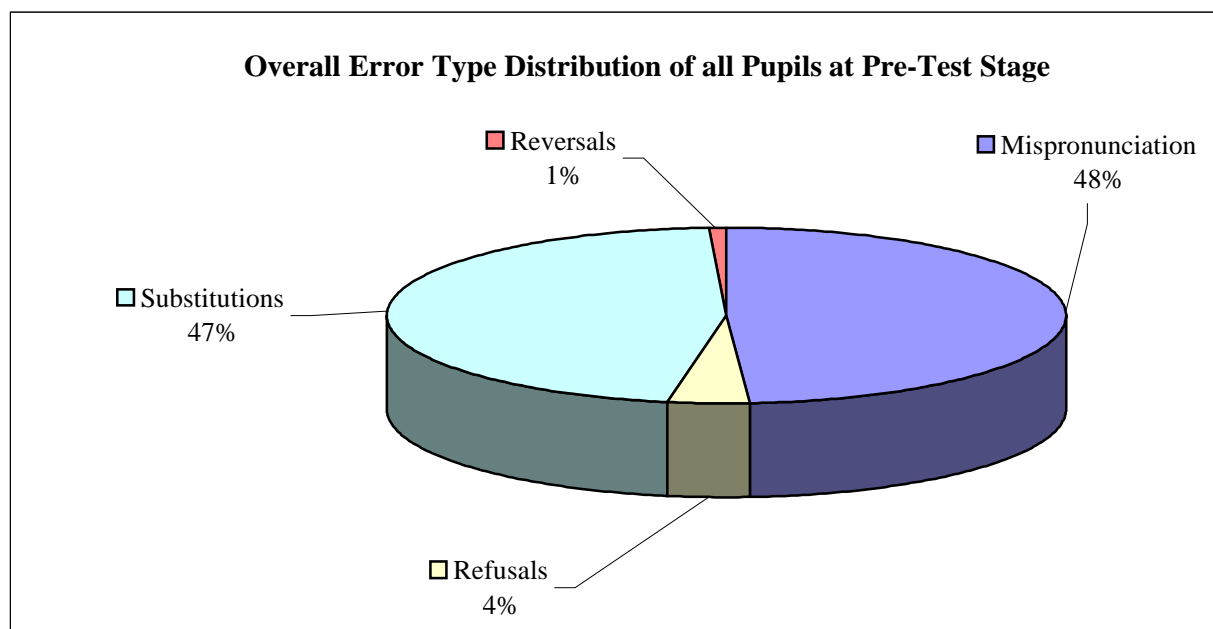


Figure 4: Overall Error Type Distribution of all Pupils at Pre-Test Stage

To investigate the Reading Accuracy performance of the children in more detail it is useful to look at the overall distribution of the different errors that occurred during the reading of the short passages of text in the NARA II Neale Analysis of Reading Ability tests. Figure 4 summarises this data in a useful graphical representation context. Note that other types of error i.e. additions and omissions, were not included as the only types of error that were recorded at pre-test stage were mispronunciations, substitutions, refusals and reversals. The two main types of error that occurred during pre-test stage were mispronunciations (48%) and substitutions (47%). The fact that mispronunciations are the most common type of error is rather unsurprising as pronouncing a word requires the child to decode the word phonetically, a skill in which the literature review discusses, children with dyslexia generally have difficulty in learning (Wise et al, 1999). What is also interesting regarding the findings in figure 4 is that refusals accounted for 4% of the total errors made by children at pre-test stage. A refusal error is made when a child is unable to make an attempt at a word or pauses for a considerable length of time. A possible reason for this may be lack of confidence or low self esteem in the child, once again the literature review supports this justification as it identifies dyslectics regularly experiencing due to increased frustration and repeated failure (Bingham, 1980). Figure 5 illustrates the number and type of each error each pupil made during the NARA II Neale Analysis of Reading Ability test at pre-test stage. Perhaps worthy of mention is 'Pupil E' who with an Error Total Count of 30 made more errors than any of the other pupils. However this Error Total Count is rather misleading as it can be interpreted that 'Pupil E' did not perform particularly well in NARA II Neale Analysis of Reading Ability test, when in actual fact this pupil performed fairly well, achieving a Reading Age score at pre-test stage only 5 months below his actual age. The reason 'Pupil E' has a high error count total is due to this pupil completing all 6 levels of short passages of text in the NARA II Neale Analysis of Reading Ability, thus having a higher probability of making errors than the other pupils who completed fewer levels.

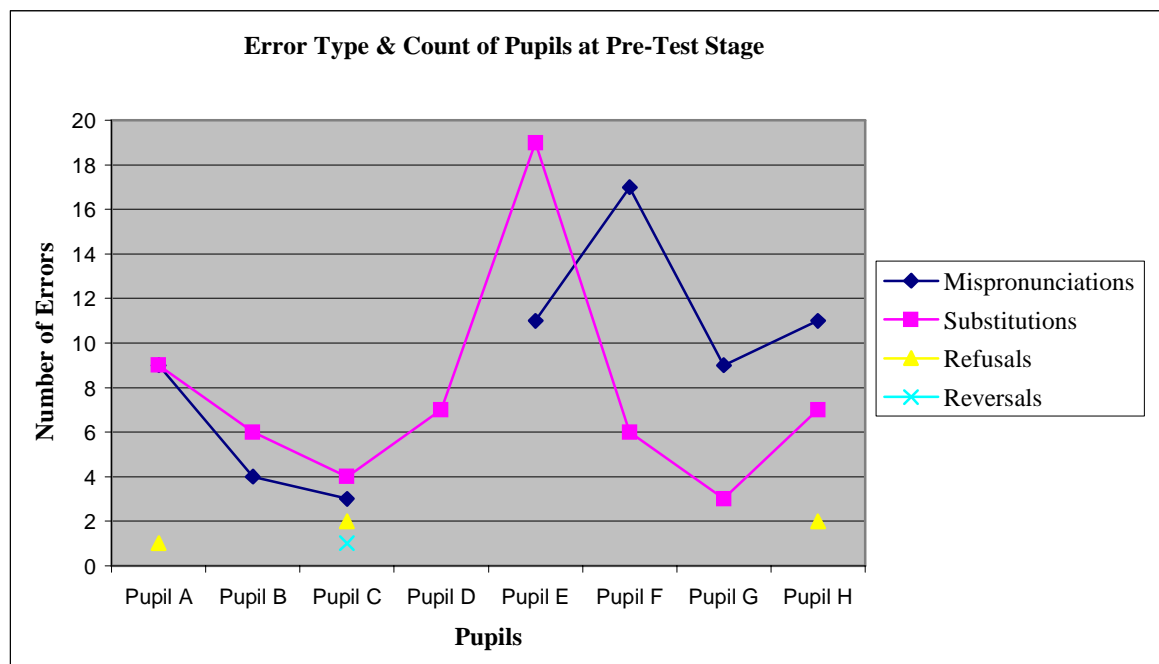


Figure 5: Individual Error Type and Count of Pupils at Pre-Test Stage

Figure 6 summarises the overall amount of errors that occurred at post-test stage for all of the pupils. Note that other types of error i.e. additions, omissions and reversals, were not included as the only types of error that were recorded at post-test stage were mispronunciations, substitutions, refusals.

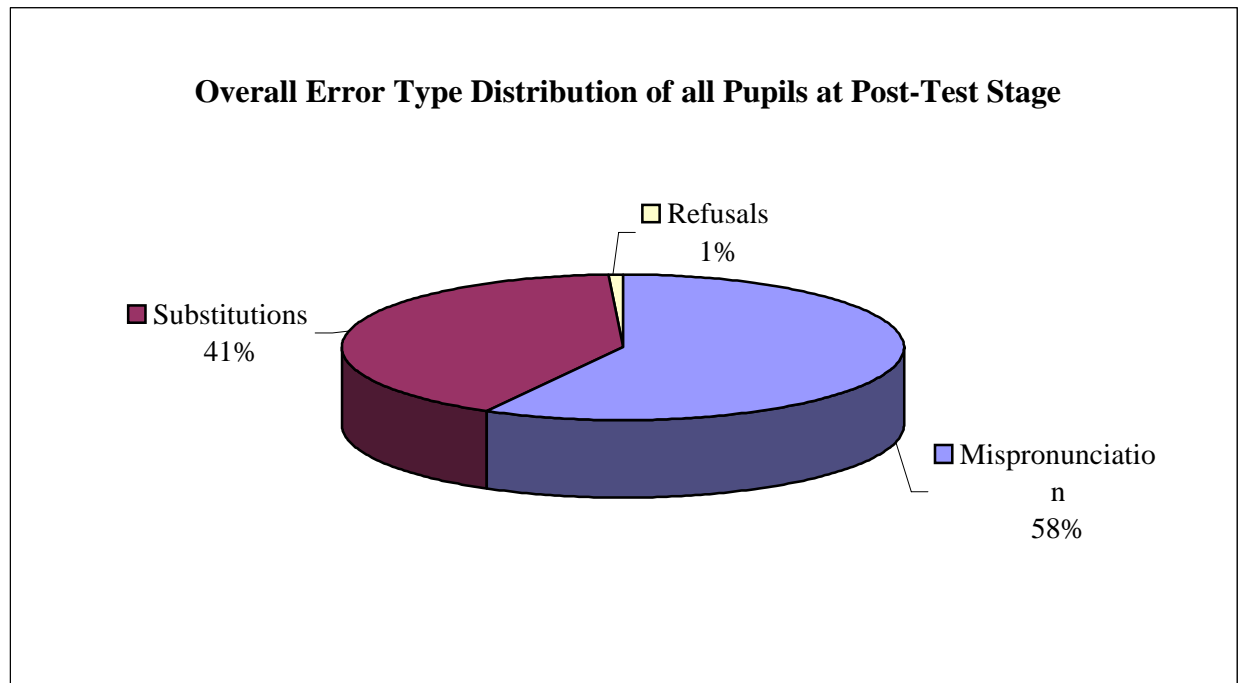


Figure 6: Overall Error Type Distribution of all Pupils at Post-Test Stage

Similarly to figure 4, the two main types of error made at post-test were mispronunciations (58%) and substitutions (41%). Although these two main types of error are somewhat expected, what is probing is that the overall occurrence of refusal type error at post-test stage is 3% less than what was recorded at pre-test stage. This could possibly suggest an increase in the pupils' confidence and self-esteem from using the Reading Assisted Software. Furthermore this could signify that particular features of the software were successful in building the pupils' self esteem, an important consideration for the selection of suitable software highlighted in the literature review.

An increase in mispronunciations error type occurrence from pre-test to post-test stage of 10% signifies that the Reading Assisted Software was unsuccessful in reducing this type of error, which as stated earlier is a particular skill dyslectics are weak in.

Figure 7 below, illustrates the number and type of each error each pupil made during the NARA II Neale Analysis of Reading Ability test at post-test stage. What is encouraging from the data displayed in figure 7 is that even 'Pupil C' who was identified earlier as being the only pupil to improve upon their Standardized Score and Percentile Rank has managed to lower the number of substitution errors and refusal errors after using the Reading Assisted Software. This again echo's the suggestion that the Reading Assisted Software was successful in improving the self-esteem of the pupils. Furthermore 'Pupil C's increased occurrence of mispronunciations type of

error reiterates the belief that the Reading Assisted Software has been unsuccessful in reducing this type of error.

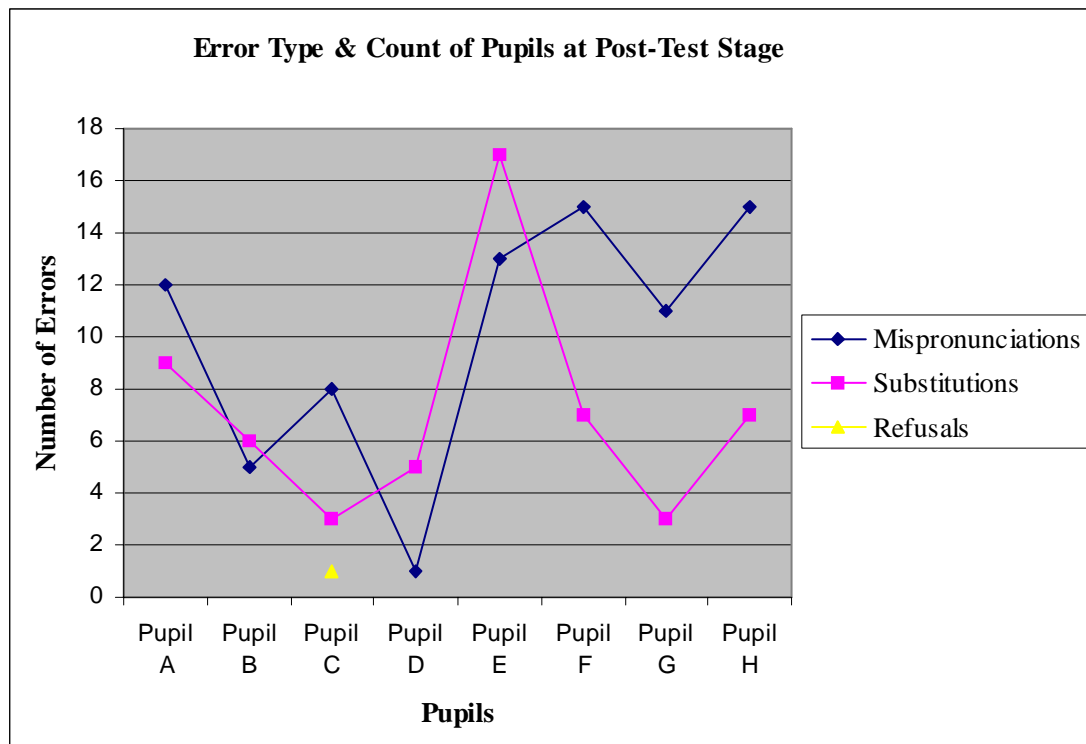


Figure 7: Individual Error Type and Count of Pupils at Post-Test Stage

4.1.2 Reading Comprehension Results

Table 2 below, summarises the pre-test and post-test reading comprehension performance of the test subjects when using the NARA II Neale Analysis of Reading Ability. By applying the reading comprehension performance results data of each child into tabular form, a comprehensive evaluation can be made regarding the results.

As mentioned previously, the mean age of the group of children used within the experiment was 9.91 years at pre-test stage, however the groups' mean Reading Age in terms of comprehension at the same stage of experiment was 7.70 years. This is a significant point because collectively as a group the children's level of reading pre-test was over 2 years (-2.20) below the reading attainment expected at the age which they were at. As discussed in the literature review, dyslectics are profoundly weak in reading comprehension due to their tendency to comprehend a text, which in actual fact is completely different from the actual text (Gregor et al., 2003). Thus explaining the mean scores for Reading Age both at pre-test and post-test stage, which are below the mean score of the actual age of the pupils.

Note that 'Pupil D' once again performed below the floor of standard scores on some tests. 'Pupil D' was the youngest tested in this experiment, 8.08 years old at pre-test stage, this may be a significant factor in why this pupil's performance was considerably poorer than the other subjects of the experiment.

Table 2: Reading Comprehension pre-test and post-test scores by children

	Age at Testing		Reading Age		Raw Score		Standardized Score		National Percentile Rank	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Pupil A	9.06	9.06	8.07	8.07	18	19	90	93	26	32
Pupil B	10.06	10.07	8.10	8.10	20	20	88	89	22	24
Pupil C	9.04	9.04	7.09	7.08	15	14	88	88	22	22
Pupil D	8.08	8.09	6.01-	6.01-	4	3	70-	N/A	1	1
Pupil E	11.01	11.02	12.05	11.01	33	29	105	100	63	50
Pupil F	12.05	12.06	10.09	10.08	28	28	93	94	32	34
Pupil G	10.01	10.02	8.10	8.10	20	20	91	91	28	28
Pupil H	10.02	10.02	8.10	8.10	20	20	91	91	28	28
Mean	9.91	9.92	7.70	7.57	19.75	19.13	80.75	80.75	27.75	27.38

The most noticeable observation that can be made from the reading comprehension performance data in table 2 is that collectively, the pupils' mean score for Reading Age has in fact declined from pre-test stage (7.70) to post-test stage (7.57). This depreciation in Reading Age is reflected in 3 of the individual results to, as 'Pupil C', 'Pupil E' and 'Pupil F' are all reported to have performed worse at post-test stage. However 'Pupil E' performed extremely well at pre-test stage in reading comprehension and although a difference of 1 year and 4 months in Reading Age is recorded from pre-test (12.05) to post-test stage (11.01) scores, this pupil was still able to demonstrate a respectful level of reading comprehension at post-test stage. The results of the reading comprehension performance are similar in some respects to the findings of Mathew (1996) who although never reported a decline in the users' reading comprehension performance, found that there was no significant improvement in the users comprehension after using the Reading Assisted Software.

A possible cause for the depreciation in terms of reading comprehension Reading Age of the pupils may be due to the Reading Assisted Software being unsuccessful in providing meaningful tasks that were targeted at improving its users' reading comprehension. Furthermore another possible explanation may be due to the length of time the children used the Reading Assisted Software in the experiment, for example had the experiment length been increased and the children used the software for longer, results may have been better. There is some evidence which supports this justification in table 2, where 'Pupil A' and 'Pupil B' narrowly missed out on improving their Reading Age at post-test stage but still showed signs of improvement in their Standardized Score and Percentile Rank at post-test stage.

4.1.3 Reading Fluency Results

The third and final element of reading that was assessed using the NARA II Neale Analysis of Reading Ability was Reading Fluency. Table 3 below, summarises the pre-test and post-test reading fluency performance of the test subjects. The results regarding the pupils reading fluency performance were very interesting. Firstly, the mean age of the group of children used within the experiment was 9.91 years at pre-test stage, however the groups' mean Reading Age in terms of reading fluency at the same stage of experiment was 6.17 years. This meant that collectively the children were approximately 3.74 years below their actual age in terms of the rate at which they were reading. The results also pointed out that of the three elements of reading i.e. Accuracy, Comprehension and Fluency, the children performed worse at pre-test stage in reading fluency. The literature review chapter noted that children with Dyslexia have difficulty in fluently reading text Fawcett (2004).

Table 3: Reading Fluency pre-test and post-test scores by children

	Age at Testing		Reading Age		Raw Score		Standardized Score		National Percentile Rank	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Pupil A	9.06	9.06	6.01	6.10	30	28	76	77	6	6
Pupil B	10.06	10.07	12.10+	12.10+	113	97	117	109	87	72
Pupil C	9.04	9.04	6.01-	6.04	24	22	70-	73	1	4
Pupil D	8.08	8.09	6.01-	6.01	18	20	70-	N/A	1	4
Pupil E	11.01	11.02	7.07	7.09	48	41	83	78	13	7
Pupil F	12.05	12.06	9.05	9.05	65	61	88	84	22	14
Pupil G	10.01	10.02	7.07	8.01	48	44	87	86	20	18
Pupil H	10.02	10.02	8.05	8.05	56	49	91	89	28	24
Mean	9.91	9.92	6.17	7.81	50.25	45.25	67.75	74.5	22.25	18.63

Despite the children recording a mean Reading Age score for their reading fluency which was nearly 4 years below their mean actual age at pre-test stage, the results at post –test stage showed significant signs of improvement. The mean score for Reading Age at post-test stage (7.81) was approximately 1.64 years better than the mean score for Reading Age recorded at pre-test stage. This is a significant improvement and could suggest that the Reading Assisted Software was successful in improving the children's' reading fluency. The improvement in reading fluency is reflected in the individual results of table 3. 5 of the 8 children that participated in this experimentally based evaluation type of project demonstrated an increase in the fluency of their reading. Pupils 'A', 'C', 'D', 'E' and 'G' all showed signs of improvement at post-test stage. It should be noted that 'Pupil D' recorded a Reading Age score (6.01) at post-test stage that was not below the floor in the Reading Age category for the first time as it had previously been below the floor in this pupil's reading accuracy performance and reading comprehension performance results. The

improvement in reading fluency suggests and further supports the belief that the Reading Assisted Software increased the children's self esteem and confidence, which is satisfying as Humphrey (2003) explains that the role of the teacher first and foremost is to build self-confidence in pupils with dyslexia. Therefore the Reading Assisted Software to some extent has adopted this pedagogical objective.

4.2 Results of User Based Evaluation

The section will present and discuss the results obtained from the User Based Evaluation, which as mentioned in the methods chapter was conducted in the form of a semi-structured interview with the 8 subjects of this experiment at post-test stage. The complicated nature of the questionnaire meant that a semi-structured interview technique was used to ask the children questions that had been prepared on the questionnaire. By applying a combination of open-ended questions and Likert scale type questions within the semi-structured interview, the results of this method provided an effective indicator of the usability of the software and to the level of users subjective satisfaction with the software's interface, ease of use and overall satisfaction with the software. Therefore this section details how usable the children thought particular features of the software were and also presents and discusses the children's subjective satisfaction with the Reading Assisted Software. By focusing on each element separately a more clear representation of the results can be drawn out.

4.2.1 Usability of the RAS

The open-ended questions asked within the semi-structured interview were designed specifically to get an understanding of how useable the children felt the software was and how useful the children felt particular features of the software were.

During the semi-structured interview the children were asked if it was difficult to move the games central character 'Tintin' around the game. By asking this question an assumption could be made from the child's response regarding the ease of navigating around different areas of the Reading Assisted Software. All of the 8 children interviewed felt that that navigation was generally quite good. Some of the related comments given by the children were:

"It was quite easy, I just used the arrow keys to move him around."

"Tintin moved when I used the arrow keys, it was easy to move him about."

"I've used arrow keys before on some other computer games I have, so I thought it was simple to find my way about."

From the Interview it was found that the children had become quite dependent on the text to speech feedback facility of the Reading Assisted Software. This data is summarised in Figure 8 below. Out of 8 children interviewed 7 of them gave their frequency of using the text to speech feedback facility either a 4 or 5 rating. With a 5 rating being the highest rating on the scale and thus representing usage of the text to speech feedback facility all the time, it is conclusive that the children used this facility of the Reading Assisted Software frequently. 'Pupil E' who gave the lowest rating (3) for frequency of using the text to speech feedback facility stated that this facility

“took ages in reading the text.”

A main objective of the software was making children aware of famous people who have been successful in life despite having dyslexia. When the children were asked about their thoughts on any aspect of the software, which they liked, remarkably 6 of the 8 children said that they had enjoyed finding out about the famous personalities in the software. Some of the comments provided were:

“My favourite thing was when we were told about the famous people, the guy with the dreadlocks was cool.”

“The best thing was definitely learning about all the famous people who have dyslexia.”

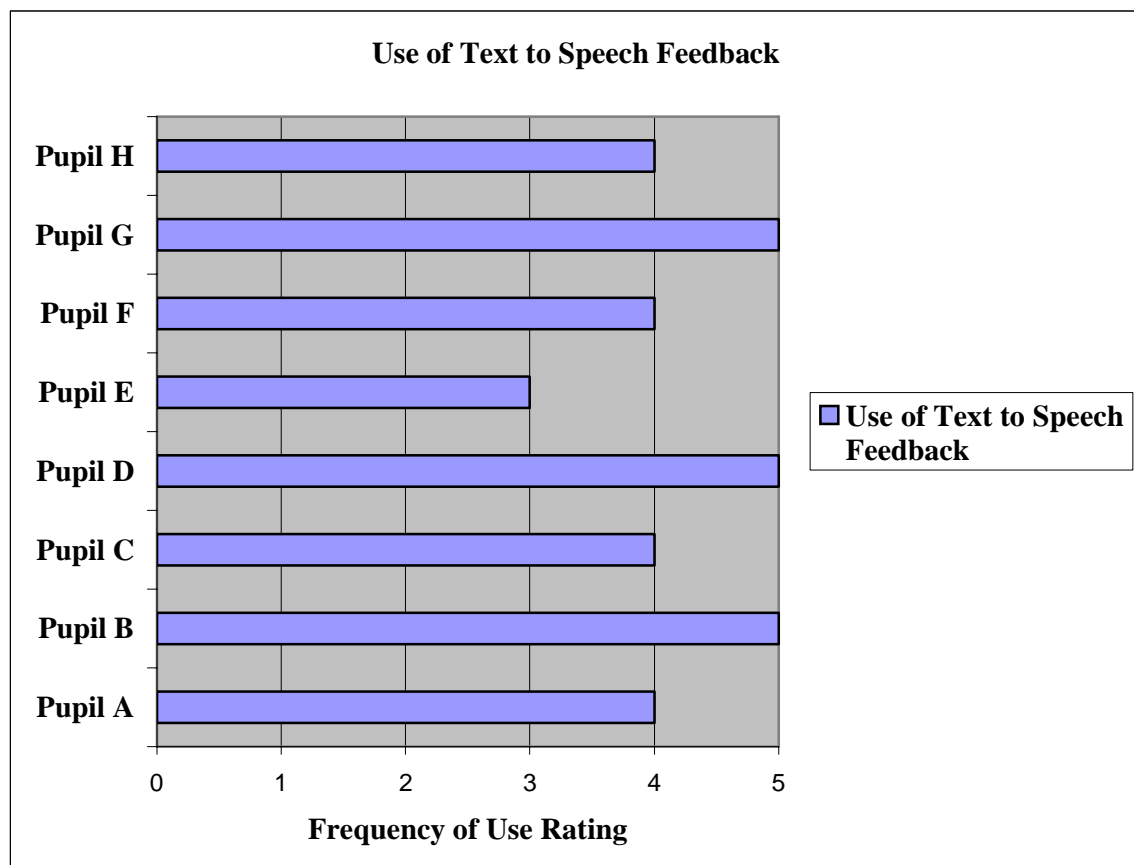


Figure 8: Use of Text to Speech Feedback facility on RAS

Similarly the children were asked during interview if there was any aspect of the software, which had not liked. The children’s answers were varied, however 3 of the children said that they hadn’t enjoyed the ‘snap’ game which was essentially a small game which challenged the children to drag and drop items into different coloured baskets as they answered particular questions about a text in which they had just read.

Some of their comments were:

“The game where you had to drop the items into the baskets was hard, I didn’t like it.”

“The ball wouldn’t go into the basket for me, it was a bit annoying.”

From the interviews it was found that from the total of 8 children, all 8 of them would use the Reading Assisted Software again, which was quite an encouraging result. ‘Pupil D’ asked “do you have any other games with you?” This question perhaps typical of the children’s acceptance of the using the software and could also be a testament to the general good usability of the software.

4.2.2 Children’s Subjective Ratings of the RAS Results

Subjective Ratings of the Reading Assisted Software were calculated by the subjects’ level of agreement to a particular statement regarding the software on the five-point Likert scale. A rating of 5 indicates strong and total agreement with a statement whereas a rating of 1 indicates strong and total disagreement with a statement. The child asked during the interview, to what extent on the scale would they agree with the following statements about the software: annoying; confusing; frustrating; interesting; easy to use and fun. The results of the children’s subjective ratings of the software are summarised in Figure 9 below. Figure 9 is an effective representation of the subjects’ ratings as it details their responses in the interview to both negative and positive statements about the software (Dillman, 2000), thus ensuring the respondent had to think carefully about there rating.

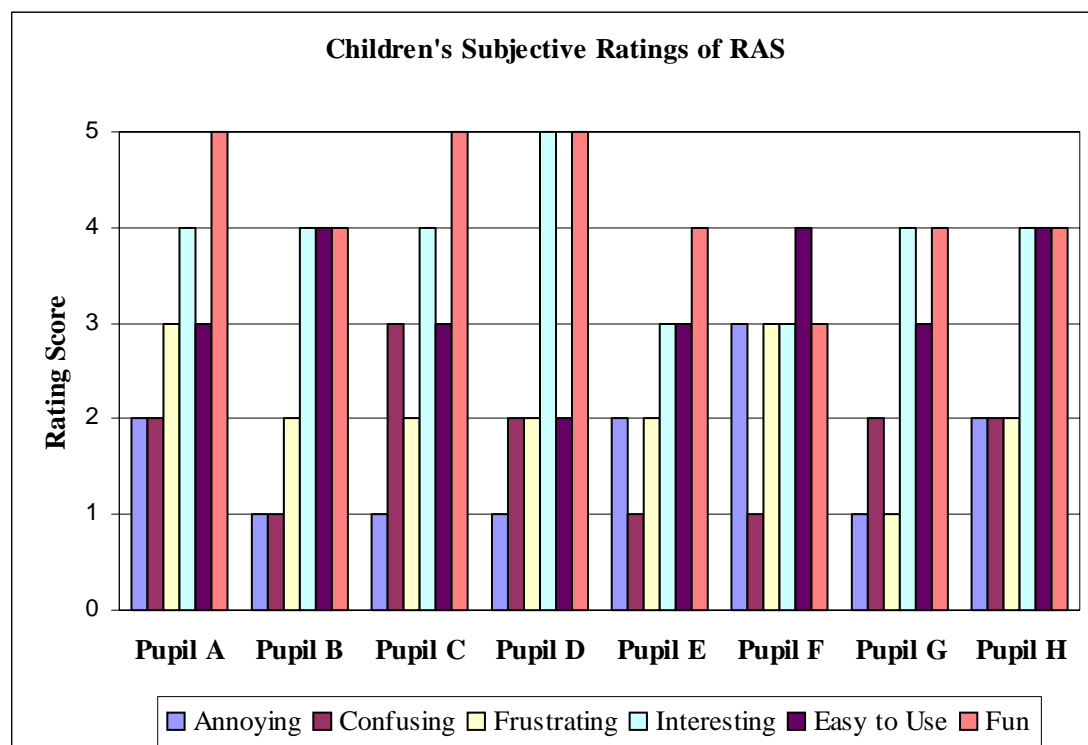


Figure 9: Subjective Ratings of Reading Assisted Software

Overall the subjective ratings of the software were quite positive. Figure 9, shows that 7 of the 8 children interviewed strongly agreed that the software was fun to use by giving it a 4 or 5 rating. Furthermore 6 of the children interviewed strongly agreed that the software was interesting. However the results in figure 9 show that collectively the children's subjective ratings of the software being easy to use were varied, a mean score of 3.25 suggest that although the software may have been fun and interesting it could have potentially have been easier to use. It is also worthy of mention that 'Pupil D' was 8.09 years old at time of interview and as identified earlier as being the youngest member of the group of participants for this experiment strongly disagreed that the software was easy to use with a rating of 2. This is a significant point as it could perhaps question the appropriateness of the software being specifically targeted at dyslexic children aged 8 –13 years. The age category bracket of the software could be further questioned as 'Pupil F', the oldest member of the group who was 12.06 years old at time of interview found the strongly agreed that the software was annoying (rating of 4) and frustrating (rating of 4). As this is a small sample of subjects 'Pupil F' and 'Pupil C' may have subjective feelings regarding the software that is reflective of children of the same age in a larger sample of children.

4.3 Pedagogical Expert Evaluation

The results from the children's learning support teacher's pedagogical evaluation generally were very favourable towards the pedagogical impact of the Reading Assisted Software. The following are some of the results of the teacher's pedagogical evaluation report:

- Then children were said to have enjoyed using the software and responded well to using it. As a result the teacher noted that they "... were motivated into using the resource and therefore profit from the instructional benefits children are believed to accrue from such games. "
- The teacher was particularly positive from the motivational impact the children had to using the software and stated that this "...reflected in a number of the children demonstrating increased confidence within their reading ability, suffice to say 5 pupils demonstrated an increase in reading fluency when the 2nd Neale Analysis Reading Ability tests were carried out at post experiment stage. "
- The software was also reported by the teacher to have played a major part in improving the children's confidence and self-esteem as the teacher considered "...the fact that a pupil was consistently praised with positive feedback when a task or game was successfully completed played a significant role in building their confidence and self esteem."
- However despite the pupils having improved self-esteem and confidence, the teacher was critical of the software's ability to improve the other elements of reading i.e. accuracy and comprehension, stating, ".....further development has to be made to the resource so that additional skills such as word attacking skills and rhyme detection are incorporated within the resource."
- The teacher despite having criticisms remained positive about the software and its potential of building the children's self esteem and saw its advantages in working the software into the existing learning and teaching strategy. The teacher in the pedagogical evaluation report commented that: "...the pupils who have become familiar with the resource, can now use the resource

independently and unassisted during lessons consequently creating a more efficient teaching and learning strategy to complement a very busy SEN department. Motivated pupils can follow the program themselves unassisted.”

5. Conclusions

This section of the report will present the final overall conclusions that can be drawn from the results of evaluation methods detailed in the previous chapter of this project. A brief summary of the project work will also be discussed within this chapter. Finally the chapter will conclude with what future work could be undertaken following the results of this project.

5.1 Brief summary of Project

The purpose of this experimentally based type of project was to evaluate the effectiveness of Reading Assisted Software aimed at children with Dyslexia (aged 8-13) and whether it facilitated reading accuracy, fluency and comprehension. The Reading Assisted Software that was selected from the conclusions of the literature review was 'The Mystery of the Lost Letters', which essentially targets dyslexic children aged between 8 and 13 years of age. The subjects of the test were 8 children from School X who all had the syndrome dyslexia and were aged between 8 and 13 years.

The aim of the project was to evaluate the hypothesis that Reading Assisted Software will provide improvements in the subjects' reading ability in terms of accuracy, fluency and comprehension.

The implementation of this project involved selecting an appropriate piece of Reading Assisted Software, putting it in a classroom environment for 4 weeks with the test subjects using it for two thirty minute sessions a week, and measuring the reading ability using the NARA II Neale Analysis of Reading Ability formal tests, the subject's reading performance scores at pre-test and post-test stages. By doing so effective conclusions were drawn as to the effectiveness of the Reading Assisted Software.

The effectiveness of the Reading Assisted Software was evaluated using 2 other collaborative methods of evaluation to further support the results drawn from the NARA II Neale Analysis of Reading Ability formal tests. These two other methods were: a user based evaluation to evaluate the subjective usability of the Reading Assisted Software from the subjects perspective, and a pedagogical expert evaluation completed by the subjects Learning Support Teacher to evaluate the pedagogical impact of the Reading assisted Software.

On completion of all 3 evaluations methods, the Reading Assisted Software did not fully satisfy the project's hypothesis. All three elements of reading were not improved; only reading fluency had been facilitated through application of the Reading Assisted Software. The following sub sections of this chapter draw together the detail of the presented points and individual conclusions of the Results chapter and their impact on the overall research question of this investigation.

5.2 Final Discussion of Results

The study detailed within this report was designed to investigate the issue of whether Reading Assisted Software intervention with dyslexic children aged between 8 and

13 years could facilitate their reading accuracy, comprehension and fluency. The results of this small-scale study suggest that the software was successful in improving reading fluency of the children but did not fully satisfy the investigations hypothesis, as reading accuracy and reading comprehension performance were not improved upon. Although reading accuracy performance did report a small but insignificant improvement with 'Pupil B' and 'Pupil C' demonstrating an improvement in their respective Reading Age and Standardized Scores, it did not influence the collective mean score for the group in terms of Reading Age, which remained at 7.18 years at post-test stage. However a potential reason why the children reading accuracy data did not demonstrate an improvement may have been due to the fact that mispronunciations type of error occurrence at post-test stage increased and remained the most common type of error type at this stage. This implies that the software was unsuccessful in improving the phonological Awareness of the children, a skill, which the literature review identified as being extremely important to be taught at school as it builds accuracy of reading (Snowling, 1995).

The most satisfactory result for the group lay in the improvement in fluency of reading. This suggested that the Reading Assisted Software had not only been successful in improving the reading fluency of children but had also increased the confidence and self-esteem of the children. The improvement in reading fluency is extremely encouraging, as dyslexic children's reading performance has been found to progress at a slower rate. Thompson (1984) in an evaluative study into dyslexic children's reading and spelling performance found that a dyslexic child is averaged to make 5 months improvement in reading a year. Furthermore evidence that self-esteem in the children had improved was recorded in the user-based evaluation and pedagogical expert evaluation of the pedagogical impact of the software. Six of the eight children in the semi-structured interview said that they had enjoyed finding out about the famous personalities in the software. A main objective of the software was making children aware of famous people who have been successful in life despite having dyslexia. The idea behind this was to encourage the children and feel more confident. The Learning support teacher commented that the children felt more motivated from using the program and commented: "...the fact that a pupil was consistently praised with positive feedback when a task or game was successfully completed played a significant role in building their confidence and self esteem." The teacher's pedagogical comments are supported by Hillage (2000), a member of the Dyslexia Association Computer Committee, who agrees with the connotation of the children in this study feeling more confident from using the Reading Assisted Software. Hillage explains that computerized aids such as Reading Assisted Software are beneficial for dyslexic children they provide "immediate feedback without criticism or judgement that may arise in the classroom." A reduced number of refusal type errors recorded at post-test stage reiterated the belief that the software increased the self-esteem of the dyslexic children, a principle which Humphrey (2003) in the literature describes as been of great importance when teaching dyslexic children.

Despite an apparent improvement in reading fluency, disappointingly the performance of the children over both stages of testing indicated no improvement in reading comprehension. The fact that individually 3 pupils worsened in their reading comprehension performance and that collectively there was evidence of a decline in reading comprehension performance was surprising. The results of the reading comprehension performance were similar in some respects to the findings of Mathew

(1996) who although never reported a decline in the users' reading comprehension performance, found that there was no significant improvement in the users' comprehension after using the Reading Assisted Software. A possible cause for the depreciation in terms of reading comprehension Reading Age of the pupils may be due to the Reading Assisted Software being unsuccessful in providing meaningful tasks that were targeted at improving its users' reading comprehension. Certainly the results of the user-based evaluation imply that children found the 'snap' task particularly difficult, a task specifically designed to develop reading comprehension. The pupils were reported to have found it difficult to drag and drop items into different coloured baskets as they answered particular questions about a text in which they had just read. Inkpen et al (1996) in a comparison study of interaction styles noted that children preferred better when they used point and click interaction techniques rather than drag and drop interaction techniques as they found it easier to understand. Furthermore another possible explanation may be due to the length of time the children used the Reading Assisted Software in the experiment, for example had the experiment length been increased and the children used the software for longer, results may have been better. There is some evidence which supports this justification in table 2, where 'Pupil A' and 'Pupil B' narrowly missed out on improving their Reading Age at post-test stage but still showed signs of improvement in their Standardized Score and Percentile Rank at post-test stage.

5.3 Future Work

It is worth noting that the NARA II Neale Analysis of Reading Ability method although was an effective method in measuring the reading performance of the children in this study at pre-test and post-test stage, it was not without its limitations. Reading accuracy is the controlling dimension, which ultimately dictates when the testing ends, therefore testing may prohibit a pupil from achieving a better comprehension score. Similarly the point at which the testing stops can have an impact on the rate of reading score the pupil can achieve as the this score is based on the average score for all completed levels i.e. it is possible for a pupil to slowly struggle through a level and therefore bring down their overall reading speed; whereas if they had failed to complete the level, their overall speed would remain higher. Therefore in order to take this research investigation further, a more comprehensive study with other formal method of measuring the reading ability such as the Phonological Assessment Battery test used in Wood's (2005) study need to be used. In order to sufficiently generalise on the effectiveness of the Reading Assisted Software a more comprehensive study with the target group on a wider scale and wider-term has to be made. The results of this investigation suggest that if the software was used on a wider basis, it may have the potential to have a considerable impact on the wider dyslexic populace in terms of improving aspects of their reading such as fluency.

5.4 Conclusion

It is perhaps not surprising that such a small-scale and short-term study such as this one only managed to demonstrate a consistent improvement in one element of reading i.e. fluency, but failed to demonstrate a consistent improvement in the other two elements of reading i.e. accuracy, comprehension. One very noticeable advantage of using the Reading Assisted Software with the children participating within the

experiment was that they demonstrated higher levels of enthusiasm and motivation from using the Reading Assisted Software. However Chamberlin (2003) believes that positive responses to not always yield positive results in the learning outcome. Chamberlin's sentiments reflect the results obtained in this experiment regarding reading accuracy and most definitely reading comprehension as there was no significant improvement in these aspects of the children's reading performance as has been demonstrated in their reading fluency performance.

However it should be noted that in line with Thompson's (1984) estimation of dyslexic children only improving 5 months every year, this study challenged the validity of Thompson's estimation as the subjects of the experiment of this study showed signs of improvement in only one month of using the Reading Assisted Software i.e. in their reading fluency. Therefore this study's research question of does Reading Assisted Software aimed at children with Dyslexia (aged 8-13) facilitate reading accuracy, fluency and comprehension, should be answered that yes it most definitely does facilitate reading fluency, however it could be argued that if the length of the study had been prolonged the likelihood of reading accuracy and comprehension of children with dyslexia aged 8-13 years being improved would have greater.

The rationale behind this investigation was in allowing teachers who often are too busy to make more valued selections in software in future for this target domain. The findings of this project are useful to these teachers because not only are the teachers able to select an appropriate piece of software for their pupils but the findings suggest that the pupils have the potential to work independently with the software thus allowing the teacher the ability to not feel so overworked and be able to focus more so to other teaching matters.

Another beneficiary of the outcome of this project may be the software developers' themselves, because not only to they strive to make the software as usable as possible but essentially their main intention is to improve the target user's performance in the specified academic domain e.g. reading. The project findings will be interesting to the developers, as it will inform them as to which particular aspects of the software were responsible for elements of reading being improved i.e. outputting positive feedback to users and the text to speech facility, or which particular aspects of the software were not particularly effective i.e. the 'snap' game targeted at improving comprehension.

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7. Appendices

APPENDIX A – INTERVIEW TRANSCRIPT WITH PUPIL A

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil A: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil A: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil A: "2"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil A: "2"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil A: "3"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil A: "4"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil A: "3"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil A: "5"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil A: "It was quite easy, I just used the arrow keys to move him around."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil A: “4”

Me: “What aspect of the software did you enjoy the most?”

Pupil A: “Finding out about the people with dyslexia.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil A: “ The game where you had to drop the items into the baskets was hard, I didn’t like it.”

Me: “Can you remember the name of that game?”

Pupil A: “I think it was called ‘Snap’.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil A: “Yes”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX B – INTERVIEW TRANSCRIPT WITH PUPIL B

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil B: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil B: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil B: "1"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil B: "1"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil B: "2"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil B: "4"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil B: "4"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil B: "4"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil B: "No, I thought it was simple."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil B: “5”

Me: “What aspect of the software did you enjoy the most?”

Pupil B: “Probably finding Professor Calculus.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil B: “The music was rubbish.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil B: “Yes”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX C – INTERVIEW TRANSCRIPT WITH PUPIL C

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil C: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil C: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil C: "1"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil C: "3"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil C: "2"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil C: "4"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil C: "3"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil C: "5"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil C: "It was quite easy."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil C: “4”

Me: “What aspect of the software did you enjoy the most?”

Pupil C: “Learning out about the famous people.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil C: “ Trying to find the last hidden item in the Hall of Fame.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil C: “Yes”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX D – INTERVIEW TRANSCRIPT WITH PUPIL D

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil D: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil D: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil D: "1"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil D: "2"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil D: "2"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil D: "5"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil D: "2"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil D: "5"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil D: "Nah it wasn't."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil D: “5”

Me: “What aspect of the software did you enjoy the most?”

Pupil D: “The best thing was definitely learning about all the famous people who have dyslexia.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil D: “The butler always got in my way.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil D: “Yes, do you have any other games with you?”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX E – INTERVIEW TRANSCRIPT WITH PUPIL E

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil E: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil E: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil E: "2"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil E: "1"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil E: "2"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil E: "3"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil E: "3"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil E: "4"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil E: "No."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil E: “3. It took ages in reading the text”

Me: “What aspect of the software did you enjoy the most?”

Pupil E: “The part about the dyslexic people was good.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil E: “ Listening to the music, but I turned that off.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil E: “Yes.”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX F – INTERVIEW TRANSCRIPT WITH PUPIL F

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil F: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil F: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil F: "4"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil F: "1"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil F: "4"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil F: "3"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil F: "4"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil F: "3"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil F: “Tintin moved when I used the arrow keys, it was easy to move him about.”

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil F: “4”

Me: “What aspect of the software did you enjoy the most?”

Pupil F: “Getting the keys to the next room.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil F: “The ‘Snap’ game. The ball wouldn’t go into the basket for me, it was a bit annoying.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil F: “Yes.”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX G – INTERVIEW TRANSCRIPT WITH PUPIL G

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil G: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil G: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil G: "1"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil G: "2"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil G: "1"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil G: "4"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil G: "3"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil G: "4"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil G: "Not really."

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil G:”5”

Me: “What aspect of the software did you enjoy the most?

Pupil G: “My favourite thing was when we were told about the famous people, the guy with the dreadlocks was cool.”

Me: “What aspect of the software didn’t you enjoy?

Pupil G: “I don’t know.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil G: “Yes.”

Likert Type Ratings Questions Scoring System

Scoring. As indicated in the report, the Likert based questions have a 1 to 5 scale, below is the scoring system of each rating.

- 1 = Totally Disagree
- 2 = Strongly Disagree
- 3 = Moderately agree
- 4 = Strongly agree
- 5 = Totally agree

APPENDIX H – INTERVIEW TRANSCRIPT WITH PUPIL H

Participant in the Interview were myself i.e. the interviewer, the child i.e. the interviewee and the child's teacher.

Me: "Thank you for participating in this interview. Again I must stress that it is not you that is being tested it is the effectiveness of the 'The Mystery of the Lost Letters' software that is being tested. So when you're ready I'll ask you a few questions on your opinions of the software. Do you understand?"

Pupil H: "Yes"

Me: "Okay then, please indicate on a 1 to 5 scale, 5 meaning that you strongly and totally agree with how well the words I say describe the software and 1 meaning that you strongly and totally disagree with how well the words I say describe the software. Do you understand?"

Pupil H: "Yes"

Me: "Okay then. How well does the word 'Annoying' describe the software you used?"

Pupil H: "2"

Me: "How well does the word 'Confusing' describe the software you used?"

Pupil H: "2"

Me: "How well does the word 'Frustrating' describe the software you used?"

Pupil H: "2"

Me: "How well does the word 'Interesting' describe the software you used?"

Pupil H: "4"

Me: "How well does the words 'Easy to Use' describe the software you used?"

Pupil H: "4"

Me: "How well does the word 'Fun' describe the software you used?"

Pupil H: "4"

Me: "Okay then. Now I'm going to ask you some questions about your use of the software, again I want you to give me your honest opinions."

Me: "Was it difficult to move 'Tintin' around the game?"

Pupil H: "No. I've used arrow keys before on some other computer games I have, so I

thought it was simple to find my way about.”

Me: “Again on a 1 to 5 scale with 5 meaning you used it all the time and 1 meaning you never used it at all, how often did you need to use the text to speech facility?”

Pupil H: “4”

Me: “What aspect of the software did you enjoy the most?”

Pupil H: “It was learning about the famous people.”

Me: “What aspect of the software didn’t you enjoy?”

Pupil H: “Probably the ‘Snap’ game.”

Me: “Would you use ‘The Mystery of Lost Letters’ again?”

Pupil H: “Yes.”

APPENDIX I – PEDAGOGICAL EXPERT EVALUATION REPORT

Having been asked to observe the participants of the study i.e. eight of the SEN pupils, make use of the educational software, 'The Mystery of The Lost Letters', for a period of 4 weeks some interesting observations were noted during this period of time.

The children responded to the induction of the software favourably as many of the children were already familiar with the software's main character 'Tintin' from the popular children's TV program. The resource proved to be very popular amongst the children in the fact that the children enjoyed playing the games. The fact that they enjoyed these games is worthy of note as the children were motivated into using the resource and therefore profit from the instructional benefits children are believed to accrue from such games. The children particularly enjoyed the games with the moving objects and testing their skill with the mouse.

The motivational impact of using the software reflected in a number of the children demonstrating increased confidence within their reading ability, suffice to say 5 pupils demonstrated an increase in reading fluency when the 2nd Neale Analysis Reading Ability tests were carried out at post experiment stage. I consider the fact that a pupil was consistently praised with positive feedback when a task or game was successfully completed played a significant role in building their confidence and self esteem. One pupil in particular took obvious delight in being told that he had successfully completed the game and found the missing 'Professor Calculus.' However should the resource be successful in improving other key aspects of reading i.e. comprehension and accuracy my suggestion would be that further development has to be made to the resource so that additional skills such as word attacking skills and rhyme detection are incorporated within the resource.

Application of "The Mystery of The Lost Letters" proved to be a useful tool in motivating the pupils and played a significant part in building the self-esteem of pupils. Thus said such a resource could prove to be extremely advantageous in assisting these pupils with their reading, certainly the positive results affiliate this. In addition to this a successful trial of this software within the classroom environment suggests that the pupils who have become familiar with the resource, can now use the resource independently and unassisted during lessons consequently creating a more efficient teaching and learning strategy to complement a very busy SEN department. Motivated pupils can follow the program themselves unassisted.

APPENDIX J –NARA II TEST FORM 1 & 2 RESULTS FOR ALL CHILDREN

Please Note the complete results of this appendix are attached in the hard copy of this report.