STANDARDISING THE DESIGN OF EDUCATIONAL COMPUTER READING PROGRAMS FOR CHILDREN WITH AUTISM

Marian Tuedor

Middlesex University

School of Engineering and Information Sciences

Middlesex University

Submitted for Degree of Doctor of Philosophy

at the Middlesex University

December 2009

Abstract

Educationalists working in the sphere of special education, psychologists and software engineers continue to debate the efficacy of technology interfaces and the merits of information technology with regard to supporting learning in children with Autistic Spectrum Disorder (ASD), and the need to standardise software design for this group. This research argues that, for these children to optimise the use of this technology, it must be designed to meet the learning needs and characteristics of this condition, and so a design/development standard is needed.

There is currently no instruction to aid educational professionals in choosing suitable computer programs that can be employed to support learning to read in children with ASD. The present research offers a rigorous comparative analysis of the multimedia conditions. A selection instruction (SI) was developed to facilitate the choice of appropriate computer programs for children with ASD, and forms part of the pilot study for this investigation, which was later modified and developed into an educational computer programs design standard. This SI serves as a set of guidelines that is intended to assist professionals and the parents/guardians of children with ASD in their search for good, useable programs that will assist in the acquisition of early reading skills by this group.

This research advocates the development of effective computer programs based on individualistic considerations and the stringent application of Human Computer Interaction (HCI) principles in the design of multimedia computer technology for children with ASD.

Two educational programs were employed in the investigation, and the data collection method included quantitative (pre-tests; a comparative study of children with ASD and typically developing children in video-recorded sessions, and post-tests) and qualitative (interviews, and an attitude questionnaire) methods. This approach was triangulated, thereby promoting the validity and rigour of the investigation.

The present research concludes that, although there were recorded gains in the application of computer technology to teach new words to children with ASD, there were problems relating to the appropriateness and suitability of the programs for the children employed in this research, as detected during the interviews and from the attitude questionnaires, noting the need for autistic preferences in the design and development of these educational computer programs.

This investigation offers a broader approach to the theoretical understanding and explanation of autistic learning styles, reading methodologies and issues relating to the design, development and usability of multimedia computer technology. Attention is drawn to the inadequacy of the existing technology and research into ASD and how the disorder affects learning in these children.

Acknowledgements

I wish to express a vote of thanks to the staff and students of Woodfield School and Advance Educational Services, for their help with this investigation. A big vote of thanks to my supervisors Tony White, Fabia Franco and Serengul Smith for directing and overseeing this research.

Thanks to my children whom I love dearly for being my inspiration and being patient with Mum throughout this research. Thanks to my family for their support through this period. Most of all, thanks to God, from whom I get my strength and focus.

TABLE OF CONTENTS

ABSTRACT i
ACKNOWLEDGEMENT ii
TABLE OF CONTENT iii
TABLE OF TABLES vi
TABLE OF FIGURES ix

CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION 1
1.2 AUTISTIC SPECTRUM DISORDER (ASD) 4
1.2.1 History of Autism 5
1.3 Thesis Layout 9
1.4 PURPOSE 10
1.5 ARCHITECTURE OF THE INVESTIGATION 11
1.6 CHAPTER SUMMARY 12

CHAPTER 2 LITERATURE REVIEW

3.1 INTRODUCTION 13
3.2 CHAPTER SUMMARY 26

CHAPTER 3 METHODOLOGY

3.1 INTRODUCTION 27
3.1.1 The Computer Programs 28
3.2 THE UNDERPINNING THEORIES 30
3.2.1 Core learning theories 31
3.2.2 Reading theories 41
3.3 METHOD 45
3.3.1 Initiation phase 1 45
3.3.2 Data Collection phase 2 54
3.3.3 Writing-up phase 3 56
3.4 ETHICAL CONSIDERATIONS 58
3.5 CHAPTER SUMMARY 60

CHAPTER 4 EMPIRICAL STUDY INVESTIGATION i: EXPERIMENTAL

(PRE-AND-POST TESTING)

4.1 INTRODUCTION 61
4.2 METHOD 62
4.2.1 Participants 63
4.2.2 Procedure 65
4.3 RESULTS 68
4.4 CHAPTER SUMMARY 69

CHAPTER 5 EMPIRICAL STUDY INVESTIGATION ii : USER INTERACTION

5.1 INTRODUCTION 70
5.1.1 Background 70
5.2 METHOD........ 73
5.2.1 Participants 73
5.2.2 Procedure 74
5.2.3 The coding scheme 75
5.2.4 Data reduction 79
5.3 RESULTS 80
5.3.1 Visual attention 80
5.3.2 Motivation. 82
5.3.3 Boredom and /stress 84
5.4 CHAPTER SUMMARY 86

CHAPTER 6 EMPIRICAL STUDY INVESTIGATION iii: INVESTIGATING ATTITUDES

6.1 INTRODUCTION 87
6.2 METHOD 88
6.2.1 Participants 88
6.2.2 Procedure 88
6.3 RESULTS 93
6.4 CHAPTER SUMMARY 99

CHAPTER 7 EMPIRICAL STUDY INVESTIGATION iv: ELICITING OPINIONS (INTERVIEW)

7.1 INTRODUCTION 100
7.2 Interviews I (Eliciting the Professionals Opinions) 101
7.2.1 Method 101
7.2.2 Participants 102
7.2.3 Procedure 102
7.2.4 Results 106
7.3 Interviews II (recommendation consultation) 109
7.3.1 Method 109
7.3.2 Participants 109
7.3.3 Procedure 109
7.3.4 Findings and Recommendations 110
7.4 CHAPTER SUMMARY 111

CHAPTER 8 DISCUSSION

8.1 INTRODUCTION 112
8.2 EVALUATION OF THE COMPUTER PROGRAMS 113
8.2.1 Discussion of the Empirical Study Investigation i (Pre- and Post-test) 114
8.2.2 Discussion of the Empirical Study Investigation ii: User Interaction 116
8.2.3 Discussion of the Empirical Study investigation iii (Attitude Questionnaire) 124
8.2.4 Discussion of the Empirical Study iv: Eliciting Opinions (Interviews) 130
8.3 ASSESSMENT OF THE TWO COMPUTER PROGRAMS 136
8.4 DISCUSSION OF THE RESEARCH METHODOLOGY 140
8.5 DISCUSSION OF THE RESEARCH METHOD 144
8.6 THE CONTRIBUTIONS 151
8.6.1 Selection Instructions (SI) 151
8.6.2 Educational Computer programs Design Standards (ECPDS) 162
8.6.3 Comparing the Selection Instructions (SI) and Educational 189
8.7 CHAPTER SUMMARY 190

CHAPTER 9 CONCLUSION

9.1 CONCLUSION 191

REFERENCE

REFERENCE 196

Table of Tables

Table 1.1 Principal Acronyms Employed in the Thesis 4
Table 2.1: Summary of Reviews 24
Table 3.1: Profile of the Computer Program FM....................30
Table 3.2: Profile of the Computer Program SM 30
Table 3.3: Review of the Learning Theories Applied in this Investigation....................44
Table 3.4: Data Collection and Analysis 56
Table 4.1: Pre- and Post-Test Results Software FM 68
Table 4.2: Pre- and Post-Test Results Software SM 68
Table 5.1 Profiles of the Participants with ASD 73
Table 5.4: Looking Time for Software FM (TD) 81
Table 5.5: Looking Time for Software SM (TD) 81
Table 5.12: Results for the Duration of Boredom/Stress for FM (ASD)....................85
Table 5.13: Results for the Duration of Boredom/Stress for SM (ASD). 85
Table 5.14: Results for Boredom/Stress for the FM (TD) 86
Table 5.15: Results for Boredom/Stress for the SM (TD)....................86
Table 6.1: Analysis of Attitude Questionnaires 91
Table 6.2: Sample of the Recommendations 92
Table 6.29: Mean Scores (FM) Questions 1-18, 22-25 94
Table 6.30: Mean Scores (SM): Questions 19-21 94
Table 6.31 Mean Scores (FM) Questions: 1-18, 22-25 94
Table 6.32 Mean Scores (SM): Questions 19-21 94
Table 7.1: Detailing the Data Analysis Process....................105
Table: 7. 2: Problems with the Computer Programs (TAs)....................107
Table: 7.3: Problems with the Computer Programs (HCs) 107
Table 7.4: Problems with the Computer Programs (TAs) 108
Table 7.5: Problems with the Computer Programs (HCs) 108
Table 8.1 Summaries of the Results within the Context of the Hypotheses 126
Table 8.2 The Findings of the Empirical Studies Linked to the Design Guidelines....................166
Table 8.3: Communication Stages in ASD 170
Table 8.4: Categories of Adaptation System 184
Table: 8.5: An Adaptable Agent for ASD 186
Table: 8.6: Assistive Technology Devices for ASD 188

Additional tables in <u>appendices</u>

Table 5.2: Looking Time for Software FM (ASD)....55
Table 5.3: Looking Time for Software SM (ASD) 55
Table 5.6: Frequency of Touch Behaviour Following Different Types of Prompt in Software FM (ASD) .55
Table 5.7: Frequency Of Touch Behaviour Following Different Types Of Prompt In Software SM (ASD) 55
Table 5.8: Frequency Of Touch Behaviour Following Different Types Of Prompt In Software FM (TD) ...56
Table 5.9: Frequency Of Touch Behaviour Following Different Types Of Prompt In Software SM (td) 56
Table 6.3: Attitude of TAs - Usability Based Questions (FM) 56
Table 6.4: Attitude of HCs - Usability Based Questions (FM) 56
Table 6.5: Attitude of TAs- Usability Based Questions (SM)....56
Table 6.6: Attitude of HCs - Usability Based Questions (SM) 56
Table 6.7: Attitude of TAs- Structure And Content Of The Programs (FM)....57
Table 6.8: Attitude of HCs - Structure And Content Of The Programs (FM) 57
Table 6.9: Attitude of -TAs Structure And Content Of The Programs (SM) 57
Table 6.10: Attitude of HCs- Structure And Content Of The Programs (SM)....57
Table 6.11 Attitude of -TAs Learning Style of the Users (FM)....57
Table 6.12: Attitude of HCs - Learning Style Of The Users (FM) 57
Table 6.13: Attitude of TAs- Learning Style Of The Users (SM) 57
Table 6.14 Attitude of HCs - Learning Style of the Users (SM)....58
Table 6.15: Attitude of TAs– Enjoyment / General Questions (FM) 58
Table 6.16: Attitude of HCs – Enjoyment / General Questions (FM)....58
Table 6.17: Attitude of TAs – General / Other Questions (SM) 58
Table 6.18: Attitude of HCs – General / Other Questions (SM) 58
Table 6.19: Disagreement over the TAs in FM....59
Table 6.20: Disagreement Over the HCs in FM 59
Table 6.21: Disagreement Of Both TAs software SM 60
Table 6.22: Disagreement Of Both HCs software SM....60
Table 6.23: Different Levels of Agreement in TAs attitudes (FM) 60
Table 6.24: Different Levels Of Agreement in HCs (FM)....60
Table 6.25: Different Levels of Agreement in TAs attitudes (SM) 61
Table 6.26: Different Levels Of Agreement in HCs (SM) 61
Table 6.27 Agreements in the Scores of the TAs....61
Table 6.28 Agreements in the Scores of the HCs 61
Table 7.6: Proficiency Of The Computer Program TA (s) 62
Table 7.7: Proficiency Of The Computer Program (HCs) 61
Table 7.8: Proficiency of the computer program (TAs)....61
Table 7.9: Proficiency of the Computer Program (HCs) 62
Table 7.10: Recommendations Made (TAs) 62
Table 7.11: Recommendations Made (HCs) 62
Table 7.12: Omissions from the FM Computer Program....63

Table 7.13: Omissions from the SM computer program....63
Table 7.14 Findings and Recommendations from the Interviews 64

Table of Figures

Figure 1.3: Architecture of this Investigation 11
Figure 3.1: Example of the “Speaking for Myself” Computer Program 28
Figure 3.2: Example of the “Sentence Master” Interface 29
Figure: 3.3: Typology (A and B) of the Layout of the Video Recording 55
Figure 4.1: The Experiment Test Design for Children with ASD 63
Figure 4.2: Samples of Symbols in the Widigit Software 64
Figure 4.3: Samples of the PECS Flashcards 64
Figure 4.4: Plan View of the Video Recording via Two Camcorders 66
Figure 4. 5: Example of the “Speaking For Myself” Interface. 67
Figure 4.6: Example of the “Sentence Master” Interface 67
Figure 5.3: Sample of the video recording 75
Figure 5.4: Looking Time In Percentages For Software FM (ASD) 80
Figure 5.5: Looking Time In Percentages For Software SM (ASD) 80
Figure 5.6: Looking Time In Percentages Software FM (TD) 81
Figure 5.7: Looking Time In Percentages Software SM (TD) 81
Figure 5.8: Frequency of Touch Behaviour Following Different Types of Prompt for the FM Software (ASD) 83
Figure 5.9: Frequency of Touch Behaviour Following Different Types of Prompts for the SM software (ASD) 83
Figure 5.10: Frequency of Touch Behaviour Following Different Types of Prompts for the FM Software (TD) 84
Figure 5.11: Frequency of Touch Behaviour Following Different Types of Prompts for the FM Software (TD) 84
Figure 5.12: Percentages of Boredom/Stress For FM (ASD) 85
Figure 5.13: Percentages of Boredom/Stress For SM (ASD) 85
Figure 6.1: Sample of the Likert Scale (Taken From The Attitude Questionnaire) 89
Figure 6.2: Summary of Attitudes towards Fm 93
Figure 6.3: Summary of Attitudes towards SM 93
Figure 6.4: Usability Attitude – FM 95
Figure 6.5: Content/Structure – FM 95
Figure 6.6: Learning Style – FM 95
Figure 6.7: Usability Attitude – SM 96
Figure 6.8: Content/Structure – SM 96
Figure 6.9: Learning Style – SM 96
Figure 7.1: Sample of the Categories Developed Using the Nudist Program 106
Figure: 8.1: Empirical Basis for the Selection Instructions Centred on Child Computer Interaction and Expert Evaluation 165
Figure: 8.2: ECPDS for ASD 165
Figure: 8.3: Information Processing in TD Children 181
Figure: 8.4: Information Processing in ASD Children 181

Figure: 8.5: Taxonomy for ASD ECP 186

Appendices

Appendix A 1

Appendix B 3

Appendix C 4

Appendix D 6

Appendix E 14

Appendix F 17

Appendix G 20

Appendix H 21

Appendix I 42

Appendix J 44

Appendix K 47

Appendix L 48

Appendix M 51

Appendix N 54

Appendix O 55

Appendix P 65

Appendix Q 71

Appendix R 77

Publications

1. Tuedor (2006) Guidelines to Selecting Appropriate Literacy Educational Computer Programs for Children with Autism Conference 2006, Technology & Persons With Disabilities Conference, Los Angeles, Ca.

2. Tuedor (2006) Universal Access through Accessible Computer Educational Programs to Develop the Reading Skills of Children with Autistic Spectrum Disorders. Universal Access in the Information Society 5(3): 292-298.

Chapter 1

INTRODUCTION

'Information technology offers scope to play, explore, be creative, in a safe, highly controllable environment - and it need not make any verbal demands.' Murray (1997)

1.1 Introduction

Educators of children with disabilities have become increasingly enthusiastic about using computer technology to support education and therapy. The use of multimedia-based educational programs which combine features such as real digitized speech, colourful graphic images and animation to accompany text makes this technology appealing to children with Autistic Spectrum Disorder (ASD); as proposed by Murray (1997), it increases the attention of children with ASD.

The debate about the benefits and limitations of using computer assisted learning for children with ASD rages on, with camps either in favour or against this technology.

Research enumerating the benefits of computer technology in its earlier days was conducted by Colby (1973), who observed that employing a multimedia computer program assisted in stimulating linguistic improvement in children with ASD.

Panyan (1984) listed the potential of computer programs for facilitating learning in children with ASD due to the presence of certain features in these tools; for example, variety, consistency and immediacy. Trehin (1994) proposed that non-verbal people with ASD (those who have problems in expressing themselves verbally) can express themselves through various media, such as voice synthesis and communication cards. Murray (1997) contended that computers can be used both therapeutically and for educating people with ASD. He maintained that computer technology offers children with ASD a positive, reinforced environment and an effective way for them to explore and learn. Murray added that computer technology enables the breakdown of information into small digestible parts that could enable people with ASD to learn.

The proliferation of multimedia computing software in the fields of education, therapy and entertainment has extended the benefits of computer technology to children with ASD and there has been much research in this domain. These researches include Heimman et al. (1993 and 1995), who demonstrated that computing technology supports and promotes learning to read among children with ASD due to the predictability and consistency that it provides for its users, and stress that children with this condition find computers easier to understand, as they do not send confusing messages, as may occur when learning in a conventional teaching environment (a child/teacher setting). Alcalde et al. (1998) contended that CAI can be a learning and teaching tool for children with intellectual disabilities. Moore and Calvert (2000) shared this view and added that computer programs can create an interesting, simulating environment for children with ASD.

Alcalde et al. (1998) stated that the computers assist learning can be an efficient way of teaching and processing information for children with intellectual disabilities. The authors recorded success in using computers to teach concepts, such as colours, shapes and body positions, to children with intellectual disabilities.

Tjus et al.’s (1998) inspired by the research of Heimman et al. (1995), extended the positive effect recorded and further demonstrated that a good multimedia program can facilitate the development of reading skills in addition to other existing resources.

Mesibov (1998) proposed that behavioural problems in children with ASD can be moderated by employing educational computing programs. Nelson et al (1997 & 2001) contended that the intervention of a motivating multimedia program might stimulate reading and communication in children with various disabilities.

Moore and Calvert (2000) concluded that a carefully constructed computer program can improve attention and motivation, and promote the learning of vocabulary in children with ASD. Williams et al. (2002) demonstrated that the children with ASD spent more time reading when they used computer-assisted instructions than when using the traditional method of reading books.

The emergence of multimedia software in the classroom has helped to catapult educational computing programs into everyday educational use and has deepened the debate about the benefits of applying this technology to support learning in children with learning and cognitive disabilities.

Some researchers who have criticised the way in which children with ASD are taught using the conventional teaching approach, as well as the technology, for being too general and not focused on the understanding of ASD and the learning style of ASD children, as proposed by Mesibov (1998), Barry and Pitt (2006), and Edelson (a) (2008). These authors attributed the failure of children with ASD to maximize the opportunity that this technology provides to a lack of understanding among the professionals regarding the learning needs of this audience. This is also largely due to the fact that little consideration is given to the issues that may affect the learning process in these children.

The use of multimedia computing technology is principally attractive due to the fact that it enables the user to navigate from one page to another or from one topic to another, thereby allowing the user to direct its own learning. Mayer (2001) proposed a cognitive theory of multimedia which is based on the congruity of the presentation mode, which combines both words and pictures (audio and visual).

Yet, for children with cognitive or learning disabilities who do not have the skills or ability to direct their learning, this sequenced series of instructional activities may prove difficult, due to their disabilities (which may include a low attention span, information processing problems, etc., as recognised by Powell (1997, 2001)).

Reushle (cited in Bardill, 2003) asserted that traditional methods of instruction are often based on behaviouristic theories which are indeed adequate for acquiring procedural and psychomotor skills. However, when the tasks involve problem solving, large amounts of knowledge or high workload requirements, designers tend to rely more on cognitive-based theories of learning and instruction.

Computer educational programs have been widely employed to support children with ASD in terms of their education and therapy, as cited by Panyan (1994) and Shapiro (2002), but much of the research and software developed ignores the core of the ASD consideration of the condition, as noted by Baron-Cohen et al. (1985), Wing (1996), Powell (2001), and Powell and Jordan (2001).

Research has shown that children with ASD are responsive to multimedia communicative learning opportunities, as observed by Panyan (1984), Trehin (1994), and Murray (1997). Murray (1997) stated that computers can be used both therapeutically and in educating people with ASD. Strokes (2006) observed that the computer technology currently employed to teach children with ASD includes:

Low technology: This technology includes visual support strategies which involve any type of electronics or battery-operated device, being typically low cost equipment, such as boards, clipboards, photo albums, and laminated picture communication systems and photographs.

Mid technology: involves complex technological support strategies, which could include battery-operated devices i.e. tape recorders, overhead projectors, etc.

High technology: involves complex technological support strategies, which could include video cameras, computers, adaptive hardware and complex voice output devices.

Stokes (2009) proposed that the most effective technology for children with ASD is video taping and computers as it employs visual and audio technology as well as providing opportunity for direct interaction.
This research for children as advocated by Stokes (ibid), is focussed on educational computer literacy programs (the high technology).

Prior to this investigation being discussed, some background will be provided on the syndrome known as ASD and literacy educational computer programs to give more depth and clarity to this research.

Due to this investigation covering varied disciplines, including psychology, cognitive psychology, computer science, paediatrics, psychiatry and education, a clarification of the acronyms used is needed, see table 1.1 (additional acronyms can be found in appendix M).

TABLE 1.1 Principal Acronyms Employed in the Thesis

Acronym	Meaning
ASD	Autistic Spectrum Disorder
ABA	Applied Behavioural Analysis
CAI	Computer Assisted Instruction / Computer Aided Instruction
CAL	Computer Assisted Learning / Computer Aided Learning
ECP	Educational Computer Programs
ECPDS	Educational Computer Program Design Standards for ASD software
FM	Speaking for myself computer software
HC	Human Computer Interaction professionals
PI	Personal Instruction
MLD	Mild Learning Disabilities (MLD)
MURASD	Middlesex University Research for children with Autistic Spectrum Disorder (this acronym was employed to describe the investigation discussed in this thesis)
SLD	*Severe Learning Disabilities (SLD)*
SM	*Sentence Master computer software*
SI	Selection Instructions
TA	Teaching Assistants

1.2 Autistic Spectrum Disorder (ASD)

Autistic Spectrum Disorder (ASD), also known as infantile, childhood or classic autism, or simply autism, is a term coined from the Greek word ‘auto’ meaning ‘self’ .The pioneers of this developmental disorder were Leo Kanner in 1943 and Hans Asperger in 1944, as proposed by Happe (1996), both of whom independently published the first accounts of this disorder. Autism is reported to affect 1 in every 100 people in the United Kingdom, as reported by the National Autistic Society (2007). The exact cause of this disorder is unknown, but research shows that genetic factors may play a part; autism may be connected with conditions that affect the brain, such as maternal rubella, tuberous sclerosis and encephalitis, as proposed by Antonio et al (1978). There is no cure for autism but, with early diagnosis and intervention, there is the possibility of living a successful life.

The acronym ASD is used to show that autism comes in varying degrees, ranging from high functioning autism or Asperger’s syndrome to more severe autism, also known as classic autism. Various authors have described autism in different ways; for example, Frith (1989) described it as a disorder of development. Damasio and Maurer (1978) compared the neurological abnormality to frontal lobe damage in adults with brain damage. They described some of the hallmarks of autism as the failure to develop social relationships, language impediment, and ritualistic and compulsive behaviour. Trevarthen et al (1998) described autism as a rare, baffling difficulty with communication and learning. Typically, autism appears during the first three years of a child's life, as reported in Britannica (1988), although Trevarthen et al (1998) argued that it takes four years before the set of symptoms can be fully identified, whilst Happe (1996) proposed that autism can be diagnosed between the ages of 3 and 4, with a greater number of boys than girls having the disorder.

Children with autism may experience significant problems in the areas of cognition, communication and social skills. The common problems shared by children with autism include a triad of impairments that consists of communication problems, imagination problems and problems with socialisation (Wing, 1996). They may have difficulties in making sense of the world (perception problems), which they may find confusing. The fact that they have problems understanding others' feelings and emotions hinders their ability to socialize and communicate. A distinguishing characteristic of autistic children is an inability to understand people (due to a cognitive deficit), problems with communication, as proposed by Happe (1996), and a lack of concentration, as contended by Siegel (2003).

1.2.1 History of Autism

The condition known as autistic spectrum disorder (ASD) was noted to exist long before it was formally recorded. Frith (1989) and Happe (1996) noted earlier accounts of various conditions throughout history that were probably this disorder. Some of the earlier accounts of people with autism include that of the wild boy of Aveyron. This account was documented in 1801 by a French doctor, Jean-Marc-Gaspard Itard, who was given charge of a 12 year old boy who had been found living in the wild. The document recorded by the doctor indicates the syndrome of the condition now known as autism. Itard's ideas about teaching the boy were passed on to his pupil, Edouard Seguin, and later to Maria Montessori, whose influence remains prominent in the teaching of special education.

Another account of this condition was noted by John Haslam in England in 1809, who recorded an account of a child who contacted severe measles at the age of one and subsequently developed symptoms that bear a close resemblance to autism. Haslam recorded that the syndrome of this child bore a similarity to autism, which includes repetitious speech and impulsive, aggressive behaviour.

In 1919, an American psychologist, Lightner Witmer, described in an article a boy aged two years and seven months, who was accepted by Witmer's special school. This boy displayed signs of autism. This account noted that, after a long period of individual teaching, the boy made progress at school and acquired practical skills.

Leo Kanner (1943), in the USA, provided one of the most frequently mentioned early accounts of autism. Kanner noted that many of the children shared a common unusual pattern of behaviour, which he later named 'early infantile autism'. In 1943, he published a paper which gave a select description of the children's behaviour and outlined which features were crucial for the diagnosis of autism. Some of the features of autism that he recorded include; a profound lack of affective contact with people, insistence on the sameness of their elaborate repetitious routine, muteness or abnormality of speech, a fascination with dexterity in manipulating objects, high levels of visual-spatial skills or rote memory skills, and an alert, intelligent appearance. Kanner emphasised the presence of the condition from birth or within the first 30 months of life. He noted that this condition was unique and distinct from other childhood conditions. Hans Asperger (1944) in Austria published a similar account regarding a group of children and adolescents with a pattern of behaviour now referred to as Asperger syndrome, as cited in Frith (1989).

Children with ASD are assessed using a baseline test expressed as an overall development quotient which ranges from 24 (a child with severe learning disability) to 100 (a most able child) as recorded in the Official Online Gateway to Higher Education and Research in the UK (HERO, 2008). The development level of ASD can be determined by a combination of various assessments which include behavioural analysis, speech/language pathology and occupational therapy. The areas that will be assessed include learning patterns, imitation, sensory integration, fine and gross motor skills, hand-eye co-ordination, cognitive performance, oral motor and receptive/expressive language skills (ibid).

ASD and Severe Learning Disabilities

Children and adults with autism often experience accompanying learning difficulties. They tend to have uneven abilities, with noticeable strengths and weaknesses. These could be Mild Learning Disabilities or Severe Learning Disabilities (Department for Education and Skills, 2006 and Robins et al, (2005)). This project focuses on the issues relating to the most challenging end of the autistic spectrum, these children also have Severe Learning Disabilities.

Reading, ASD Characteristics and Challenges

In supporting learning in children with ASD, it is essential to understand their strengths, behaviour and developmental challenges, as contended by Powell (2001), and Powell and Jordan (1997). It is essential to develop computing technologies to support or reinforce early reading or learning in general in these children in order to understand the likely factors or problems that may prevent them from fully benefiting from this technology (these problems may be associated with the ASD condition or misfit problems regarding the computer technology, environment, situation, which will be elucidated later).

- ASD is characterised by several behavioural abnormalities (which may consist of strengths and weaknesses), that may include: (most of the afore-listed characteristics and challenges in ASD are based on the empirical experience of ASD rather than on actual research).
- Socialisation, communication and imagination problems (reported by Wing, 1996).
- Savant skills (present in exceptional skills, such as musical skills; present in the midst of modest or low intellectual aptitude (reported by Hill (2004)).
- Sensory abnormalities (reported by the National Autistic Society, 2008b).
- Cognitive impediment/dysfunction, inferences, generalization (reported by Powell and Jordan, (1997) and Leslie and Frith (1990)).
- Problems as a result of a reliance on rote learning (reported by the Autism Spectrum Australia (2002)).
- Strong systemizing skills (reported by Baron-Cohen et al (2007)).
- Hyperactivity, attention, motivation, memory problems (reported by the Frith (1989) and Autism Spectrum Australia (2002)).
- Behaviour problems in ASD (as reported by Mesibov (1998)).
- Disturbance of mobility, disturbance of communication (reported by Damasio et al. (1978)).
- Problems with selection or regarding to what to attend (as reported in the Autistic Spectrum Australia (Aspect), 2002).
- Hyperlexia; a preference for written words (as reported by Bright Tots (2004)).
- Ritualistic, repetitive, stereotypical and compulsive behaviour, a failure to develop social relationships (reported by Siegel (2003) and Damasio et al. (1978)).

The main theories that explain the characteristics and deficits in ASD are the 'triad of impairment', the theory of mind, weak central coherence and the executive function or dysfunction theories.

A common problem shared by children with ASD is the 'triad of impairment', a term coined by Wing (1996), who proposed that the problems or challenges in ASD can be categorised into three parts: problems with socialisation, imagination and communication. These problems impact on learning in children with ASD, as they hinder their ability to communicate with others in a meaningful way, their ability to use their imagination and their ability to understand other people's emotional states (see chapter 3).

The ‘theory of mind’ problem postulates that children with ASD lack the ability to attribute the same mental state to others as they apply to themselves, as reported by Baron-Cohen et al. (1985). It manifests itself in problems with generalization, a deficiency in the understanding of pretence and irony (adopting a literal interpretation of language), problems with making inferences (i.e. cause and effect), etc, as reported in Baron-Cohen’s (1993) investigation to determine if children with ASD have a theory of mind. The research found that 23 out of 27 preschool children and 12 out of 14 Down’s syndrome children (85% and 86% respectively) passed the belief test, in contrast to the 16 out of 20 ASD children (80%) who failed it.

The ‘weak central coherence’, as reported by Happe (1999), explains the savant skills in ASD, such as the skills of ASD children with regard to jigsaw puzzles, painting or music. Central coherence theory specifically relates to the tendency of children with this condition to process incoming information in its context (the tendency to process contextual meaning piece-meal). Problems with central coherence include rigidity in thinking perseverance (see chapter 3).

The executive dysfunction or function theory postulates that the neuropsychological problem in ASD is linked to frontal lobe problems. Problems with their executive function may affect planning, mental flexibility and inhibition, as reported by Hill (2004), who suggested that problems with executive function may account for some of the social, planning, memory and imitation problems in people with ASD. Investigations conducted that identify these problems are the ‘Go/No Go’ implemented by Ozonoff et al. (1994), and the Stroop task test (Stroop 1935), as recorded by Frith and Hills (2003) (for more details, see chapter 3).

‘Autistic Learning Style’ (ALS)

The ‘Autistic Learning Style’ (ALS) is a phrase coined to describe the special methods that children with ASD employ in learning, as concocted by Edelson (a) (2008) and Mesibov (1998). Siegel (2003), in distinguishing ‘autistic learning disabilities’ (autistic-specific learning barriers) and ‘autistic learning style’ (autistic specific-strengths), contended that both should be taken into consideration when employing strategies to teach these children. Powell and Jordan (1997) called for the recognition of autistic abilities and disabilities. Edelson (2008) argued that, when the learning style of a child is employed in determining the modality, learning will be increased. Edelson (ibid) emphasised that attention needs to be paid to the specific learning style of the child.

Some of the learning styles used for children with ASD may include:

Autistic child-specific adaptable computer programs

Every child with ASD is different. No two autistic children are the same, and any pedagogical approach or technology employed has to be appropriate for that particular child. Therefore, a ‘child specific’ approach is needed, as supported by Powell and Jordan (1997), Powell (2001) and Siegel (2003).

Visual learning

Many children with ASD are visual learners, as reported by the National Autistic Society (2008g), Autism Spectrum Australia (2002). Children with ASD process visual information more easily than auditory information. Stokes (2006) stated that, every time visual learning is employed in technological devices for autistic children, we are giving them information through their strongest processing area.

Repetition

Repetitive learning in teaching children with learning disabilities may help to alleviate some of the learning problems associated with ASD. Children with ASD tend to like to repeat an enjoyable experience, as reported by Nind (2001).

Concrete learning

Concrete learning is one of the ASD learning styles, as reported by Peeter (2001), who recorded the benefits of using objects to teach children with ASD.

Structure and routine

Children with ASD will benefit from a learning environment that is structured, uncluttered and based on routine, as reported in the National Autistic Society (2008a). Mesibov (1998) reported a visual, structured, low-arousal environment (as the child may have sensory oversensitivity, whereby the child cannot tolerate too much stimulus).

Communication tools and styles in ASD

Many children with ASD may have learning difficulties that accompany this disorder. These children have different forms of communication methods, depending on their developmental levels (see chapter 8). The variety of ways in which children with ASD communicate include verbal communication (the use of speech), non-verbal, pointing, gestures, sign language (for example, British Sign Language (BSL)), taking the adult's hand to the desired object, the use of the Picture Exchange Communication System (PECS), the use of Visual Interaction Augmentation (VIA), or the use of words and symbols, as reported by Siegel (2003) and the National Autistic Society (2008g).

Other learning styles include:

- Learning through play (reported by Nind (2001)).
- Using humour in learning (reported by Newton (2001); who found that this is more widespread in more able ASD children).
- Operant conditioning and reward (reported by Simpson, 2001)
- A monotropic interest system, whereby the child's focus is on a fixed isolated object, as reported by Murray (1997).

A child with the disorder will have various development needs and will experience different learning strengths and weaknesses, especially regarding learning disabilities, as argued by Siegel (2003). It is imperative to take into consideration all of these factors in order for these children to enjoy the benefits of the technology, as argued by Murray (1997), who recommended the use of computers to moderate some of the problems in ASD due to the opportunities they provide (such as being predicable and structured, providing 'monotropic interest systems'[1] and providing the conditions for safe error making). However, in order to achieve a systematic approach to investigating the design of educational computer software for children with ASD, we have to examine in some depth the learning style of ASD. Understanding and applying the ALS as well as other components discussed in other chapters (see chapters 3 and 8) will facilitate the standardisation of the design of appropriate computer programs to support early reading in ASD.

This investigation aims to contribute to the standardisation of educational computer programs aimed at supporting and teaching reading for children with ASD, as recognized by Trehin (1994) and Panyan (1984), who identified these problems.

[1] This is when a child's attention is focused on an isolated object, ignoring the surrounding content.

The standard proposed in this project is based on a framework that incorporates the essential elements needed to facilitate learning in ASD employing computing technology (discussed in the following chapters). The process involves a combination of methods and methodologies from various disciplines; mental health, cognitive disabilities, software engineering, Human computer Interaction (HCI), cognitive psychology and social science. Drawing on the laid down principles in conducting research and years of experience will promote research in other domains and introduce these principles advocated them in a new way, which will facilitate the much needed standard in this domain (in the design of educational computer programs for ASD).

The research question to be investigated is:
'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'

In answering this question, this project aims to explore if a design standards, as well as methodology can be developed to inform the design of appropriate software for children with ASD at the severe end of the autistic spectrum. By so doing, this research will provide the first standards to guide the design of appropriate educational software/programs for children with ASD.

1.3 Thesis Layout

The documentation of this investigation (see below) is presented the following order: the background, definition of the purpose of this investigation and the exploration of the research questions (chapter 1), the review of the literature and examination of the underpinning methodology and method for the data collection (chapters 2 and 3), the enumeration of the findings from the four empirical study investigations (chapters 4, 5, 6 and 7) and the discussion of the contribution and the entire research (chapters 8 and 9).

This thesis is subdivided into 2 parts, as outlined below:

PART I INTRODUCTION
This part consists of chapters 1-3. It provides a background to this thesis.
PART II
(a) THE RESEARCH DESIGN, IMPLEMENTATION AND RESULTS
This part consists of chapters 4-7.
(b) DISCUSSION
This part consists of chapters 8-9.

1.4 Purpose

Research has shown that children with ASD are responsive to multimedia communicative learning opportunities, as observed by Panyan (1984), Trehin (1994), and Murray (1997), yet little research to date has investigated the most appropriate paradigm to apply when designing or developing educational computing technology for children with ASD. Nelson et al. (1997) and Tjus and Heimann (2000) all advocated REL theory; see chapter 3). The appropriate technological application and educational content of the educational programs for children with ASD is unexploited, as contended by Payan (1984). There is a limited understanding and application of the ASD learning style to software design. Professionals who are attempting to support these children through the use of computing technology fail to do so due to a lack of either technical expertise or understanding of ASD, as contended by Payan (ibid).

Baron-Cohen et al. (1985) observed that little consideration is given to the issues that may affect the learning process in these children. Baron-Cohen et al. (ibid) contended that many problems are being ignored, such as low attention span, low motivation, perception problems, pedagogy and teaching issues (that relates to this audience), and communication issues.

Clearly, there is a need for advancement in this domain. This research investigates designing appropriate Educational Computer Programs (ECP) to support/advance early reading skills (word acquisition) in children with ASD and Severe Learning Disabilities (SLD). This investigation was necessitated by the limited amount of work in this domain. The areas investigated to facilitate the understanding of the issues involved in these topics include the learning problems in ASD, current reading theories/approaches (phonetics and phonological approach, the orthographic/whole language/language experience process and the semantic and comprehension process), and the suitability of these reading theories for facilitating early word acquisition in children.

In the light of this, the aims and objectives of this investigation are as follows:

Aims

To evaluate the effectiveness of educational (reading) interactive multimedia computer programs designed to facilitate early reading skills in children aged 5-10 with ASD.

To provide standards for the design of educational reading computer programs for children with ASD.

- To investigate how to advance the use of ECP to support early reading in children with ASD.
- To provide a set of guidelines to assist professionals and the parents/guardians of autistic children in their selection of educational programs.

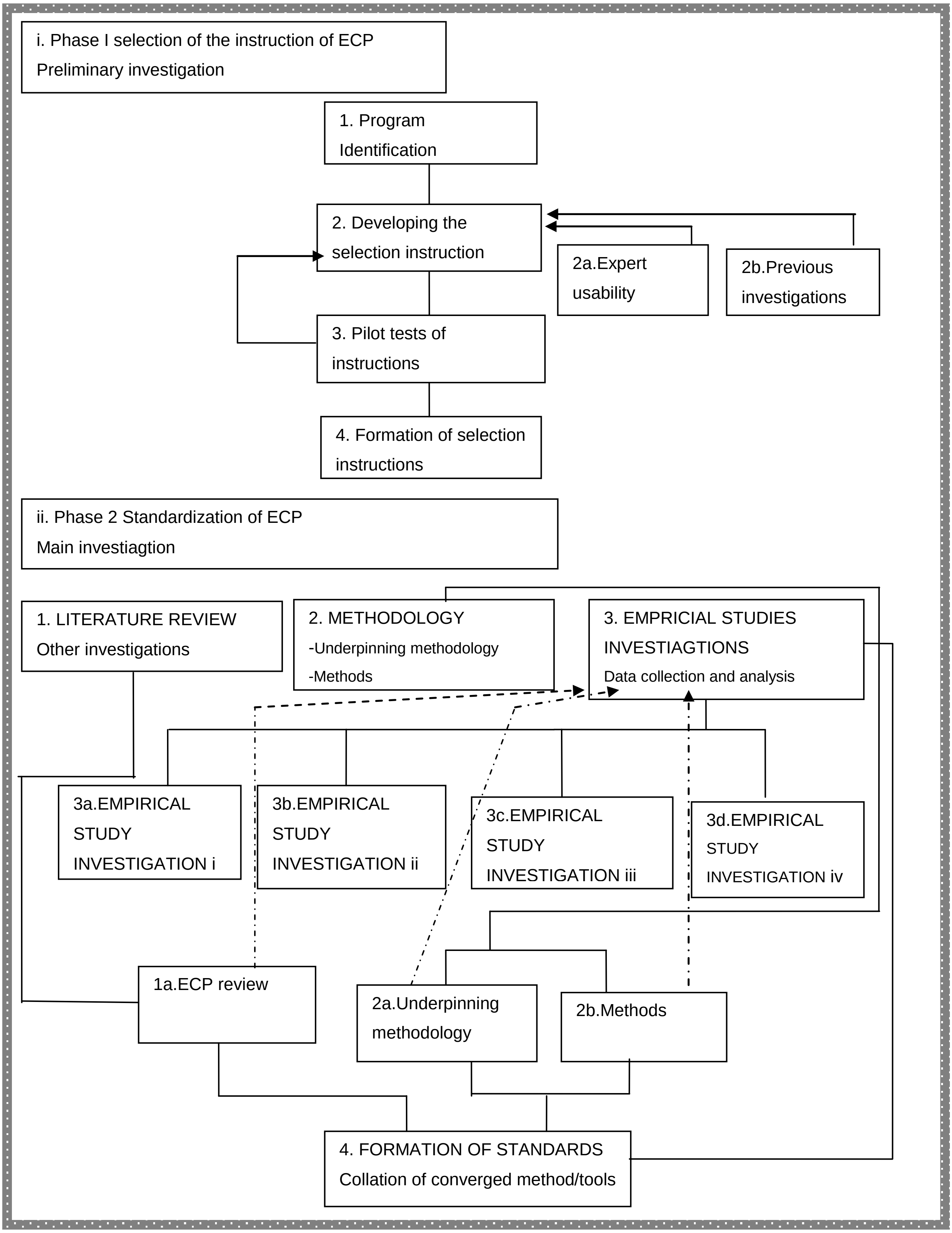
In the light of the aims and objectives, the research question is:

'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'

This will provide the forum for determining whether this technology supports learning or not, as observed by Heimann et al. (1993, 1995), Moore and Thorpe (2000) and Williams et al (2002).The research will proceed to investigate how to design appropriate educational software to support learning as a product of this investigation, and standards will be provided to guide the design of ECP for children with ASD.

1.5 Architecture of the Investigation

FIGURE 1.3 ARCHITECTURE OF THIS INVESTIGATION



This investigation aims to bridge the gap that exists between how children with autism learn best and how the materials could be presented to achieve the optimal learning of children with autism, as identified by Panyan (1984), by developing standards that will facilitate the design of appropriate computer literacy programs for children with ASD aged 5 -10.

In the light of this, therefore, the contribution of this research to scholarship (in the domain of autism and educational multimedia computer programs) will involve the formulation of a framework to guide designers and developers of educational interactive multimedia computer programs for children with ASD. This investigation will draw on other disciplines, such as mental health, cognitive disabilities, Human computer Interaction (HCI), cognitive psychology and social science, given that this domain has established methods and a methodology that will advance the research.

1.6 Chapter Summary

The chapter commences the investigation into standardising educational computer software for children with ASD. The research was necessitated by the current upsurge in computing technology that supports learning in children with ASD, yet little research has been done to standardise this process, as noted by Trehin (1994). The chapter gives the background to this research, examining the condition known as Autistic Spectrum Disorder (ASD), the history of this disorder, the challenges and problems associated with this condition and the learning disabilities and learning style associated with it. It gave definitions/explanation of the terms and acronyms employed in this document to facilitate easy readership and clarity. It discussed the research questions and the aims and objectives, and a brief appraisal of the topics to be presented later in this investigation, which include early literacy and the pedagogy of autism, and explore the issues of employing ECP as a pedagogical tool for aiding word acquisition. It provides the architecture and the structural layout of this research in this document, which will be discussed in detail in subsequent chapters. Finally, it briefly discussed the proposed contributions to the research topic in the domain of software standardisation for ASD children. The next chapter will examine related investigations with a view of providing the foundation for this project

Chapter 2

'Teaching autistic children reading can be challenging and time-consuming, but worth the effort and very rewarding.'
Glam Publisher (2008)

LITERATURE REVIEW

2.1 Introduction

Investigation into supporting children with Autistic Spectrum Disorder (ASD) using computing technology is still in its infancy, as limited research has been implemented in tailoring this technology to meet the needs of children with ASD, especially in the area of early literacy. This chapter examines the previous literature about investigations into employing computing educational programs to facilitate and support learning in children with ASD.

This chapter is split into two parts; the first examines the benefits and limitations of Educational Computer Programs (ECP) as a tool for supporting learning in children with ASD, and the second part identifies the gaps that this investigation (Middlesex University Research for Autistic Spectrum Disorder Children - MURASD) aims to address.

Computer technology is claimed by Heimann et al. (1993), Moore and Calvert (2000) and Moore et al. (2000) to be beneficial for children with ASD due to the therapeutic and educational opportunities it provides. Chen and Bernard-Opitz (1993), in an investigation which compared Personal Instruction (IP) with Computer Assisted Instructions (CAI) in four children diagnosed with ASD (the severity of the autistic condition was not specified), noted the benefits of this technology. The results of this inquiry indicate that all 4 children were motivated by the CAI, and 3 of them exhibited better behaviour when using CAI compared to PI, although no effect was found regarding the number of words learnt. The limitations of this investigation included the small sample size, the short intervention time, and the variation of the task for each child, which made the results disputable, and, finally, the aspects of learning that this inquiry aims to investigate (for example, word retention) were not defined.

One of the first researches in educational programs for children with ASD was by Colby (1973), who explored employing a multimedia computer program to assist in stimulating linguistic improvement in children with ASD.

Colby, who investigated using computer technology to promote language acquisition in 17 non-speaking children with ASD, noted that 13 of the 17 subjects showed a linguistic improvement. Although this work was beneficial to research into employing computers to support children with ASD in learning to speak, however Colby's suggestion that children with ASD lack the recognition of self due to their failure to acquire speech is unsubstantiated. Another problem with this investigation is Colby's refusal to employ the operant conditioning method (which is based on a reward system), which Colby criticised for inhibiting exploration in learning. It is contended in the current research that the application of a reward system to an educational computer program will motivate children with ASD, who are noted for having problems with motivation (as contended by Moore et al., 2000). This is buttressed by Simpson (2001), who, in an investigation on the effective practice of Applied Behavioural Analysis (ABA) for children with ASD, contended that rewards will motivate children with ASD in terms of their learning and behaviour management, although no evidence was produced to support this assertion; however, as contended by Siegel (2003) and the National Autistic Society (2008h), the principle of ABA is employed as a therapy in special education schools for children with ASD in the United Kingdom (see chapter 8).

Trehin (1994) made recommendations concerning ways to improve the reading skills of non-verbal children with ASD. He stressed that this group (those who have problems with expressing themselves verbally) can be given the opportunity to express themselves through various media computing devices, such as voice synthesis, a points system (using drawings or symbols) and communication cards. Trehin maintained that the combination or integration of the communication tools will increase the autonomy of these individuals. He recorded problems with the computing programs being too technical (designed by computer scientists who have the computing expertise to design good technical programs but who lack a knowledge of ASD) or educational professionals who provide programs with good teaching content but who lack the technical skills to design useable computer software (a lack of usability).The pertinent notion expressed by Trehin (ibid) is the need to apply what is known about a child's disability in order to support the child with technology, thereby calling for the characteristic of ASD to be included within the design of these programs. Unfortunately, no evidence was given to substantiate these recommendations and claims.

Heimann et al. (I993) observed an investigation which proposed that a planned intervention, using an interactive and child-initiated microcomputer program (ALPHA) that includes a highly motivating and interactive multimedia environment, will improve reading and writing skills in 7 children with ASD, so that the children will learn new words. The time frame for the learning of new words was eleven to seventeen weeks. The retention rate was one hundred percent. The research reported that 4 children learnt new words and gained phonological skills, 1 child made mixed progress and 2 children made no gains.

The research by Heimann et al (ibid) enumerated some of the potentials of computing technology but was too generalist and not prescriptive in its findings; for example, it failed to explore the opportunities currently omitted from computer programs, such as the lack of application of ASD preferences in their design.

In a similar investigation, Heimann et al (1995) investigated the effect of Computer Assisted Learning (CAL) in 30 children (11 with ASD, 9 with mixed disabilities, and 10 pre-school children). The quasi-experimental method was employed, and the tests were conducted on three levels (familiarisation, training and the follow-up) .The inquiry was conducted over a three to four month period. The retention rate of the participants in this investigation was less than in the previous research. In the ASD group, one child with ASD did not complete the training, and two children dropped out of the familiarization session due to a lack of interest and destructive behaviour.

The investigation (ibid) found that there was a significant improvement in reading in the ASD children (in the post test). This investigation compares various groups of children (ASD, mixed disability and pre-school), which provided a good measure of the levels of reading success of the children with ASD.

Comparing how Typically Developing (TD) preschool children respond to computer assisted learning in contrast to children with ASD, Heimann et al. (ibid) found that the ASD children in their investigation made significant gains in learning new words (with a mean score increase from 0.03 to 0.14.. Interestingly, in the follow-up test, a higher gain of 0.19 was recorded in the ASD children, whilst the TD children recorded a reduced score.

Although this was a larger investigation than the previous research (Heimann et al., 1993; discussed above), other tools that were needed to give more depth to the data collection process were not employed. For example, the observation method should have been triangulated by interviewing the teachers/parents or the more able children. The interviewing of the teachers or carers of these children could have provided a wealth of useful information that could have been included in this investigation, as supported by Denzin and Lincoln (1998), who stated that interviewing the participants provides a greater depth of understanding of a situation and leaves the interviewer better informed, although, in the case of children with ASD, interviewing the teachers/parents who could act as facilitators is more viable due to the communication problems that children with ASD may have (see chapters 3 and 8).

Murray (1997) and the National Autistic Society (2008f) make a strong case for children with ASD having access to computer technology due to the benefits it provides, which include both therapeutic and educational benefits and in terms of behavioural management. Murray maintained that computer technology offers children with ASD a positive, reinforced environment and an effective way for them to explore and learn.

Murray (ibid) also claimed that computers are of benefit to non-verbal children with ASD. He maintained that, since these children may find learning through conventional means difficult and stressful, the computer technology may alleviate these problems, as it offers the scope to play, explore and be creative, in a safe, highly controllable environment and it need not make any verbal demands. This assertion was, however, unsubstantiated, as no evidence was provided to support these claims.

These benefits, outlined by Murray, sound, but this author did not substantiate this claim with supportive evidence. He was not specific about the aspect of the autistic spectrum to which this claim refers.

Alcalde et al. (1998) contended that CAI can be a learning and teaching tool for children with intellectual disabilities. The authors noted that computer technology is a powerful tool for processing information for children with disabilities. Alcade et al (ibid) evaluated the effectiveness of the computer program "Let's play with…" (the computer program employed is based on the principles of Gagne instructional design and applied behaviour analysis) as an interactive multimedia program that teaches shapes, colours and the concepts of body position to 60 children with intellectual disabilities. The participants received instructions in four sessions of 12 trials each. The inquiry employed the drill-and-practice procedure.

Alcalde et al.'s (ibid) research found significant statistical differences between the trained and control groups regarding colour, body position and shapes. This investigation reaffirms that computer programs are a useful teaching and reinforcement learning tool for children with ASD.

One of the strengths of Alcalde et al.'s inquiry is that it examines the learning methods of children with intellectual disabilities. Applied behaviour analysis is rooted in the behaviourist psychology paradigm (which emphasises rewards) and cognitive psychology theories (the information-processing model of cognition). The authors (Alcalde et al.) paid some attention to the learning process of the subjects that this study investigates. Alcalde et al. (ibid) tried to understand and remedy some of the problems that the children with learning difficulties face when they use computer technology to learn by advocating the incorporation of Gagne's theory of learning in the design of the computer programs. However, the scope of Gagne's theory is limited, as it lacks insight into the ASD learning styles, making it unsuited for use with the autistic children.

Alcalde et al. (ibid) noted that it was important to examine the effectiveness of computer programs but failed to investigate their appropriate use for specific groups. The term 'intellectual disabilities' is too broad to give real credence to the success of these findings, as intellectual disabilities encompass disabilities ranging from Down's Syndrome,[1] Autistic Spectrum Disorder (ASD) to dyslexia.[2] It was reported in this research that extensive psychological and medical assessments were conducted of the students who participated in this study, yet only the DSM-VI[3] criteria were listed in this investigation. There is also the problem of application; as the specific disabilities of the children were not specified, it is difficult to determine to which of the varied groups of children with intellectual disabilities this treatment can be applied.

Tjus et al. (1998), akin to the authors discussed above, contended that children with ASD and various cognitive disabilities might benefit from a strategy that combines a motivating multimedia program and positive interaction with the teacher. This investigation examined the use of a multimedia program to enhance language and reading in 13 children (12 children with the diagnosis of ASD using DSM-III-R[4] and one with a preliminary diagnosis, mixed handicaps and pre-school children), replicating and refining the previous

[1] A genetic disorder in which a child is born with forty-seven rather than forty-six chromosomes, resulting in developmental delays, mental retardation, low muscle tone and other effects.

[2] A reading disorder due to a defect in the brain's processing of graphic symbols.

[3] Diagnostic and Statistical Manual of Mental Disorders (DSM-VI) is the psychiatric reference book and standard diagnostic tool employed by mental health professionals to determine the presence of autism(and other mental related disabilities).

[4] American Psychiatric Association, 1987, diagnostic manual

research and theory of Heimann et al. (1993, 1995; see above). The inquiry examined ways of applying and optimising reading in children with ASD through a theory of learning and teaching strategies.

Tjus et al. (ibid) investigation was based on a quasi-experimental design,[5] these authors recorded that reading became more rapid in the children that took part in the investigation following the intervention. The research reported word gain during the treatment period compared to the baseline period. The retention level was minimal, with data loss in one child who did not participant in the tests, while two children participated only in the initial test.

This investigation was limited, as not all of the hypotheses that this investigation aims to test were reported. The positive effect measure (on phonological awareness and decoding skills), as found in the literature, was not reported.

Moore and Calvert (2000) added that computer programs can create an interesting, simulating environment for children with ASD. These authors noted that carefully developed computer programmes can motivate children with ASD and promote their learning of vocabulary. They claim that computers are a cost-effective way of educating children who require one to one assistance in order to learn.

In an investigation, Moore and Calvert (2000) examined using computer programs to teach vocabulary in 14 children with ASD. The aim of their investigation was to compare the children's gains (in terms of attention, motivation and the learning of new words) in two types of computer program. One was behavioural-based and the other was educational-based. Both programs were designed to be comparable with each other. The object labelling drill method was used for the experiment. The children were rewarded with verbal praise or the option to play with a desired object when they responded correctly. The authors also examined the integration of computers in the classroom to supplement pedagogical practice.

The finding of this research revealed that the children were more attentive in the computer condition than the teacher-facilitated condition.

A notable feature of this investigation is that it tried to incorporate the use of a behavioural programme into the development of a computer program. The structure of the test took into account the previous treatment of the children. Like many of the investigations discussed in this chapter, this inquiry failed to assess the underlying factors that affect learning in children with ASD (the problems and characteristics of ASD), and also failed to introduce a learning model that would accommodate these issues of learning and ASD, as proposed by the theories of ASD, such as the 'theory of mind', as propagated by Baron-Cohen and Frith (1985; see chapter 3) in this investigation. Therefore, the full potential of using this technology for children with ASD cannot be realised.

[5] The quasi-experimental design is a quantitative-based research method which is based on an experimental design but lacks the random assignment of participants to groups.

There are also the issues of the lack of specification of the level of ASD at which the children tested were on the autistic spectrum, as some investigation (such as Heimann et al (op.cit), Alcalde et al. (op.cit), and Tjus et al. (op.cit)), report that the participants in the investigation are children with ASD (the severe end of the autistic spectrum) while, in actual fact, they are more able children with a mild form of ASD or Asperger's Syndrome.

Lewis' (2000) Literacy Instruction Through Technology Project (LITT) is divided into 5 interrelated studies; Study 1 investigated the literature on hypermedia-based literature in relation to children's learning needs. Study 2 investigated the learning strategies employed by students in learning to read using hypermedia-based software. Study 3 investigated the types of instruction designs needed to maximize the reading gains in hypermedia-based software. Study 4 investigated the effectiveness of hypermedia-based software in improving reading skills in children with learning disabilities. Study 5 investigated the effectiveness of hypermedia-based software in improving reading skills in children with learning disabilities who are English language learners. This research investigated the effectiveness of hypermedia-based children's literature software in improving reading skills in children with learning disabilities. This investigation noted some benefits as well as limitations in computer based learning in children with learning disabilities. The results recorded in study 2, which tested the words learnt in 6 children with learning disabilities; show that an average gain of 2.4 words was recorded. Study 3 recorded an increase in the number of words learnt as the amount of instructional support increases.

Amongst the benefits of computer technology noted by the LITT research, include the motivational appeal of hypermedia-based computer software and the fact that it can be employed to support communication in children with disabilities. However, limitations to this product were also noticed. The main limitation of the hypermedia-based children's literature permits pupils to direct the flow of the interaction with the text and other elements of these programs, but children with learning disabilities cannot fully benefit from such ventures, as they lack the strategies needed to negotiate this type of program successfully.

The project also noted that hypermedia-based programs are limited by the fact that the children navigate through the program via a sequenced series of instructional activities; for children with disabilities, choosing their own path through the software limits the interaction, as the children may not have the capability to make effective use of this learning procedure, that requires some level of initiative.

It was also reported that, although children with ASD do respond to computer multimedia programs because of the repetitive and predictable nature of the technology, the type of computer program that is employed is critical to the success of this technology for children. This study highlights both the benefits and limitations of using Educational Computer Programs (ECP), although there was no data available to substantiate many of its claims.

The LITT investigation recorded that the developer of these programs relies on the fact that exposure to the text will increase the proficiency of the pupils' reading, but this is not necessarily the case.

Learning in this condition for children with learning disabilities may be detrimental, as the child may have a limited attention span, poor concentration and may be easily distracted.

Other criticism of computer technology is based on the fact that hypermedia programs are designed for TD children who are already achieving high grades and have advanced levels of reading; pupils with learning disabilities typically achieve lower grades and lower levels of reading, which makes this technology unsuitable for these children (ibid).

The LITT project did not go far enough in addressing the issues that pertain to the problems of the learning styles of the users and issues of self/individual-focused learning (as is characteristic of the ASD disorder).

Tjus et al. (a) (2001) examined the interaction of 20 children (children with ASD and children with mixed intellectual disabilities) and their 9 teachers when working with a special multimedia program aimed at improving literacy skills. The investigation reported an increased verbal interaction between the ASD children and their teacher ($z = -2.19$, $p < 0.02$).

However, the increase in literacy skills reported in this investigation was not detailed in the report. Likewise, in this investigation, like the one stated above, the level of ASD in the child was measured as mild to moderate, indicating the focus of many investigations of this kind.

Tjus et al. (b) (2001) documented the application of the Rare Event Learning (REL) theory as a theoretical approach to teaching children with ASD. This theory proposes a combination of a set of conditions which is abbreviated to LEARN that, when combined, will produce an episode of learning for children with ASD through the children's enjoyment of the interaction with the multimedia computer program. This theory or model is limited by the fact that it is theoretical and evidence is not provided in this article to support its claims. Although it refers to other similar investigations, such as those by Heimann et al. (1995) and Tjus et al. (1998), it does not go far enough towards substantiating these claims.

Williams et al. (2002) reported that computer-based instruction was effective in teaching 8 children with ASD to read. In this investigation, it was observed that the 5 children, out of the 8 children that took part in the study made gains in terms of the number of words learnt. In terms of the time spent in the two conditions (Computer Assisted Instructions (CAI) and Personal Instructions (PI), the children were matched by age, severity of ASD and number of spoken words. The test results in all 8 children recorded more time spent reading when they used computer-assisted instruction (with a mean score of 9.9 minutes) than when using the traditional method of reading books. Inter-rater reliability was measured in order to compare the agreement (which was reported to be between seventy-five and eighty-eight percent) in the data, thereby promoting the reliability of the test results.

This research conducted by William et al. (ibid) explored the benefits of employing visual stimuli and combinations of text, sound and images but failed to explore the crucial issues that are needed for children with ASD to employ technology successfully (employing the ASD learning styles especially in the domain of information processing and communication; see chapter 8), as well as the failure to apply the appropriate level of specialist knowledge to guide this inquiry; for example, the material employed was illustrated by a children with Asperger syndrome. The authors reported this as a kind of specialist input. Firstly, having Asperger syndrome does not qualify the child as a professional in the subject, and, secondly, to base the content/materials of research of this calibre on a child's knowledge (based on his/her disabilities) is misguided.

Grynszpan et al. (2005), in an investigation of Human Computer Interface (HCI) in advancing social dialogue, understanding and spatial planning in 8 children with ASD (using 2 computer programs; 'intruder' and 'postman'), reported significant progress in spatial planning (Z=-2.383, p=0.017) but not social dialogue. This research made some important additions to the claim that computer-aided learning does benefit children with ASD (in the domain of spatial planning) but failed to develop a methodology for facilitating the design of such systems. It likewise failed to provide any systematic design instructions that will guide the future design of computer software in this domain.

Barry and Pitt (2006) contended that children with ASD have a unique learning style (their characteristics), so this should be a focus. In an investigation employing interviewing with tutors and a survey of Irish primary school teachers, they reported that, although there was a high usage of ECP in the schools, there are serious shortcomings in the design of the programs. Some of the problems highlighted include insufficient error control and inappropriate audio feedback.

Barry and Pitt (ibid) proposed the Norman (1998) interaction model and Abowd and Beale's (1991) extension of the basis for mapping special user requirements. They identified the need to focus on the unique learning style of children with ASD and proposed a model based on the cognitive load and usability of the computer software. Three components of Computer Support Learning (CSL) were proposed to be employed in the design of the proposed system; the proposal includes the application of:

- The appropriate learning scenario content (C).
- The required special education approach (I).
- The amount of cognitive guidance and support provided by the system (S).

These they described as the multidimensional approach, which includes Content, Instruction and Scaffolding (CIS). The questions that these investigations raise include:

How are these vague terminologies (discussed above) applicable to the system design?
How is the ASD learning style to be transmitted into the actual software?
What is the evidence that supports the application of the model to ASD children or users?

This proposed model appears to be more diagnostic, theoretical and prescription. It lacks evidence to support its relevance to children with ASD. The model's relevance cannot be substantiated, therefore rendering it unworkable and inapplicable.

Moore et al (2008) contended that the potential of ECP for children with ASD remains unexplored. In a literature-based investigation, Moore et al. proposed a framework for more research and development in computer-aided learning to address the core deficiencies in ASD. Some of the recommendations/areas addressed include:

- The use of drill and practicing Computer Assisted Learning (CAL) programs to teach social skills; for example, in the learning of social rules and the rules of communication.
- The use of drill and practice CAL programs to teach communication skills; for example, in the learning of conversational skills and linguistic skills.
- The use of multimedia stimulated programs to address the rigidity of thought; for example, teaching the children how and when to apply the knowledge gained in a variety of situations.

This research, however, is limited as it is based on the review of works and recommendations of various authors and does not conduct any investigation of its own to substantiate the claims that it proposed.

A standard in ECP for children with ASD needs to be achieved. As in the early days of the internet, when web pages were designed without following the standards of the User Interface (UI) guidelines, as reported by Koltringer et al.'s (2006) investigation into the design of DVDs, such is the plight of the design and development of ECP for children with ASD.

Legislation and standards

Legislation, such as the United Kingdom Disability Discrimination Act (1995) and the American Disabilities ACT (1990), stipulates that people with disabilities should not be excluded from having access to jobs and technology.

The benefits of the standards and guidelines in the design of computer software/applications include the promotion of useable systems and shortening of the iterations process in the design evaluation life cycle, as contended by Strong (1995) in a report sponsored by agencies in the United States.

Attempts have been made to address the standardization issue in software design and the internet. One such attempt is the ISO TS 16071 (Gulliksen and Harker, 2004). This venture is aimed at providing a standard aimed at promoting accessibility to all users of technology.

The Web Accessibility Initiative (WAI) (1999) is another attempt at developing strategies and guidelines to make the Web accessible to people with disabilities. These guidelines are beneficial (for example, the guideline on providing alternative tools and the inclusion of assistive technology) and can be applied to software for children with ASD in a generalist sense; however, they lack the specialist details of ASD that is needed for ASD software users.

Standards for computer technology for all people include the Europeen de Normalisation (CEN) (2003) standard CWA 14661. This CEN document covers aspects of computer hardware (covering areas such as controls, keyboards, and hardware peripherals), software (assistive technologies, pointing devices and displays) and documentation. Although the standards or guidelines provided were beneficial, however they are too general and lack the specialist guidelines needed to address the learning problem and characteristics of ASD.

There are a number of standards in the public domain that ensure that products and services meet the standard stipulated. An example of these standards is the International Organisation for Standards (ISO) (2009). These standards are produced annually and over large areas of products and services. The areas covered included mathematics, natural sciences, technology and food technology. These standards need to be applied in the design of computer programs for children with ASD; however, additional specialist standards are needed for children with ASD.

The Institute of Electrical and Electronics Engineers (IEEE) standard (2009) is another organisation that provide standards for other electrical, computing and electronic technology. However, like the other standards discussed above, these standards lack the specialist component in ASD needed to apply them.

A standard commonly in used in the United Kingdom is the BSI Standards (BS) (2009), enabling the uniformity of products. These standards ensure that the products meet the British specifications and ensure the uniformity of products. Although these are needed for the design of computing technology for children with ASD, more is needed than the general compliance standards.

The argument for the standardization and provision of guidelines for children with ASD will be one-sided if this Middlesex project does not discuss some of its limitations. The problems with the standards and guidelines, as contended by Tetzlaff and Schwartz (1991), include the limitation of using standards and guidelines that, they argue, are voluminous, vague, difficult to interpret and problematic to apply. They call for the minimisation of the use of guidelines and recommend that guidelines should be developed into complement toolkits and interactive examples. The problem with the toolkit proposed is that is a replication of a requirement specification activity and not a guide for the design of computer programs or systems. There were only 9 participants, which is limiting. Also, this proposal lacks any specialist benefits for specific groups, like children with ASD.

Henninger et al. (1995) contended that the problem with many of the standardisation efforts and guidelines was that they aimed to facilitate the design of accessible computer programs that are weak in supporting developers, technology-centred and platform-specific applications, so these are not designed for specific user groups, as is the case in children with ASD.

In educating children using computer technology, it is essential to understand the learning and developmental issues and problems that are involved in this process, and the role that these play in learning and the acquisition of knowledge, as contended by Powell and Jordan (1997). Some of the problems that children with ASD face when they come to learn include imagination, social and communication problems (the so-called ‘Triad of Impairment’), as noted by Wing (1996), social interaction (mainly to do with the inability to anticipate other people's emotions or mental states (the so-called 'Theory of Mind') as contended by Frith (1989), and Baron-Cohen (1985), hyperactivity, attention, motivation and behavioural problems, as posited by Trevarthen et al (1998), and generalisation and the transference of knowledge (Powell, 2001).

Many of the investigations (discussed above) fail to facilitate the design/development of appropriate ECP for children with ASD. Where guidelines are present, they are few and there is a failure to provide a systematic approach to the proposed guideline based on research. Trehin (1994) noted the problem of a lack of standardisation of educational programs for children with ASD and the need to develop a variety-type program that is suited to the particular needs of children with ASD, so that the technical sound and content is appropriate (see above for details). The benefit of standardising the design of ECP for children is that this will facilitate the design of appropriate educational computer programs for children with ASD (ibid).

The gaps identified include:

- The focus of many investigations is on mild to moderate ASD (as discussed above). The educative and therapeutic technological tool investigations are focused on children with mild to moderate ASD. The children in this research are discussed using the generic word 'autistic' or 'ASD' children', but the authors are actually referring to children with a mild to moderate form of ASD. There is a need to broaden the scope of the research to include children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD).

- A lack of design guidelines to facilitate the design of appropriate ECP for children with ASD that is technically sound and content appropriate (base on the national curriculum[6] on literacy) and the ASD learning style and characteristics.

- These gaps motivated the research problems (see chapter 1) and the domain investigated, which includes five areas considered for this examination, including; ASD challenges and learning style, ASD theories, the reading approach of ASD, the ASD pedagogical approach and technology, communication and ASD (see chapter 3).

[6] The National Curriculum was introduced into England, Wales and Northern Ireland as a nationwide collection of resources, teaching guidance and ideas for primary and secondary schools.

2.1 SUMMARY OF REVIEWS

Research	Topic	Overview of Limitations
Colby (1973)	Investigated using computer technology to promote language acquisition in 17 non-speaking children with ASD,	Not fully substantiated
Trehin (1994)	Made recommendations on improving the plight of non-verbal children with ASD. Called for the characteristic of ASD to be included within the design of these programs.	Unfortunately, no evidence was given to substantiate these recommendations and claims.
Heimann et al. (1993),	An investigation which proposed that a planned intervention, using an interactive and child-initiated microcomputer program (ALPHA) that includes a highly motivating and interactive multimedia environment, will improve reading and writing skills in 7 children with ASD, that the children learnt new words.	
Heimann et al. (1995)	Investigated the effect of Computer Assisted Learning (CAL) in 30 children (11 with ASD, 9 with mixed disabilities, and 10 pre-school children).	Limitation in the data collection method employed
Murray (1997)	Murray (1997) and the National Autistic society (2001f) make a strong case for children with ASD having access to computer technology due to the benefits it provides	No evidence to support them
Alcalde et al. (1998)	Evaluated the effectiveness of the computer program "Let's play with…" (the computer program employed is based on the principles of Gagne instructional design and applied behaviour analysis) as an interactive multimedia program that teaches shapes, colours and the concepts of body position to 60 children with intellectual disabilities.	Problem of application (Gagne's theory is limited in scope)

RESEARCH	TOPIC	OVERVIEW OF LIMITATIONS
Tjus et al. (1998)	Examined the use of a multimedia program to enhance language and reading in 13 children	Not all of the hypotheses that this investigation aims to test were reported.
Moore and Calvert (2000)	Examined using computer programs to teach vocabulary in 14 children with ASD.	No tables or graphs provided to illustrate the results.
Lewis' (2000) Literacy Instruction Through Technology Project (LITT) is divided into 5 interrelated studies	(5 studies) Study 1: investigated the literature on hypermedia-based literature in relation to the children's learning needs. Study 2: investigated the learning strategies employed by students in learning to read using hypermedia-based software. Study 3: investigated the types of instruction designs needed to maximize the reading gains in hypermedia-based software. Study 4: investigated the effectiveness of hypermedia-based software in improving reading skills in children with learning disabilities. Study 5 investigated the effectiveness of hypermedia-based software in improving reading skills in children with learning disabilities who are English language learners.	ASD children lack the strategies proposed in the investigation.
Tjus et al. (a) (2001)	Examined the interaction of 20 children (children with ASD and children with mixed intellectual disabilities) and their 9 teachers when working with a special multimedia program aimed at improving literacy skills.	Report lack details

RESEARCH	TOPIC	OVERVIEW OF LIMITATIONS
Tjus et al. (b) (2001)	Documentation of the application of the Rare Event Learning (REL) theory as a theoretical approach to teaching children with ASD	No evidence provided
Williams et al. (2002)	Computer-based instruction was effective in teaching 8 children with ASD to read	Some evidence provided was inadequate
Grynszpan et al. (2005),	Investigation of Human Computer Interface (HCI) in advancing social dialogue understanding and spatial planning in 8 children with ASD	Failed to provide any systematic design instructions that will guide the future design of computer software
Barry and Pitt (2006)	A survey of Irish primary school	Insufficient error control and inappropriate audio feedback
Moore et al. (2008)	A literature-based investigation into teaching ASD children	Claims were unsubstantiated
Standards Web Accessibility Initiative (WAI)) Europeen de Normalisation (CEN) Organisation for Standards (ISO)Electrical and Electronics Engineers (IEEE) standard BSI Standards (BS)	Standards in the public domain	Lacked specialist knowledge

2.2 Chapter Summary

The proliferation of multimedia computing software in providing educational and therapeutic support for children with ASD has been the focus of much research; for example, Heimman et al. (1993 and 1995), Alcalde et al. (1998), Nelson et al (1997 and 2001), Williams et al. (2002) and Grynszpan et al. (2005). Yet, there are no standards for facilitating the design of appropriate literacy programs for these children.

This chapter reviewed the past investigations into educational computer software, discussing the benefits and limitations of computing technology research and identifying the need to standardise the design and development of educational computer literacy programs for children with ASD. The next chapter provides the foundation for the MURASD project; it discusses the underpinning methodology employed in researching this investigation as well as examining the data collection and analysis methods utilized.

Chapter 3

METHODOLOGY

3.1 Introduction

Children with Autistic Spectrum Disorder (ASD) are frequently hindered from fully benefiting from computer technology due to the design limitations of Educational Computer Programs (ECP). Acquiring early reading skills through Computer Assisted Learning (CAL) can be better supported if proper consideration is given to the ASD condition (as proposed by Jordan and Powell, 1990). Finding the right methodology to investigate improving computer technology that will better support ASD children is not an easy task, as little research has been carried out in this domain, as contended by Trehin (1994) and Panyan (1984), who identified this problem. What is needed is a systematic approach, which investigates and combines the various subject areas that play a role in researching this domain; they include ASD and Human Computer Interaction (HCI), research methods, as well as empirical software engineering.

In order to provide the level of detail needed to discuss this topic, this chapter is divided into three parts: firstly the theory underpinning this investigation is discussed, followed by the data collection method employed (including the planning and implementation of the processes and procedures; from the literature review, to the implementation, the data collection and analysis and the interpretation of the results); and, lastly, other pertinent considerations are discussed, including the issues of informed consent (ethical issues), validity and bias.

The previous chapter has highlighted various attempts but there has been no systematic approach to researching and evaluating these products in the public domain. The first task faced in this project is to determine the most appropriate methodology to employ in researching this topic.

3.1.1 The Computer Programs

Twenty software packages[1] were identified as potential software to be utilized, from which two programs; the 'Speaking for Myself' (FM) and 'Sentence Master' (SM) was selected for this project (using the Selection Instructions (see chapter 8).

Speaking for Myself

The computer program 'Speaking for Myself' (see figure 3.1) is an educational program manufactured by Topologika. The program is a multimedia-based program aimed at promoting early language, communication, reading and ICT skills. The target audience for this program are children aged 2-9 years old with special educational needs. The program combines the use of audio, video and animation paraphernalia. The computer platform is the PC/Mac. The area of the curriculum it addresses is reading and communication. The skills required of the user to use this computer program are familiarity with the touch screen or mouse clicking skills.

The program utilises methods to teach language and reading skills. The program combines on-screen and printable resources. The features of the program include talking stories, flash cards of everyday words, nursery rhymes, and the sorting of matching numbers and shapes. The navigation of the computer screen is done by clicking buttons on the interface. No audio command/prompt is given in this computer program at appropriate times. No prompt or repetition is present in this computer program.

FIGURE 3.1 :EXAMPLE OF THE "SPEAKING FOR MYSELF" COMPUTER PROGRAM

The computer program narrating a story

Sentence Master

The Sentence Master program (see figure 3.2) was written by Blank (1996) and manufactured by Laureate LTD. It is a linguistic-based reading program that combines multimedia technology and printing resources. It

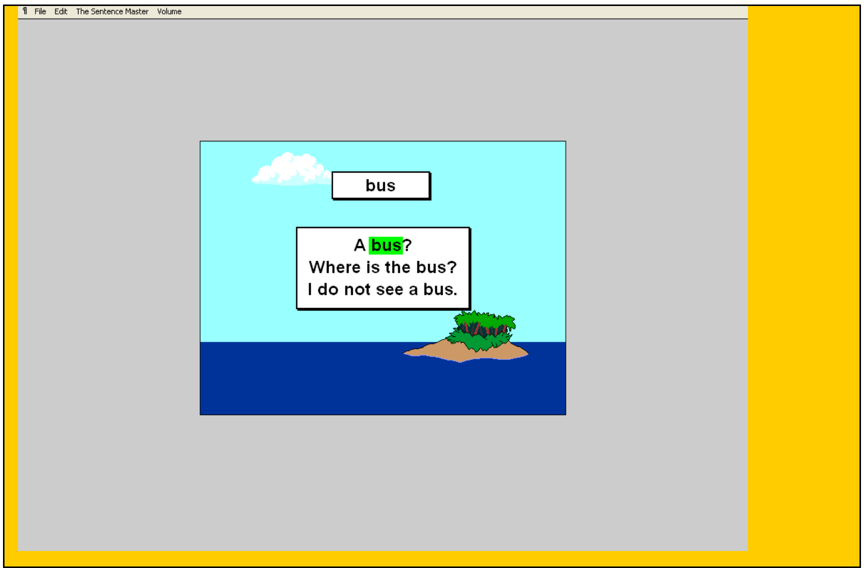
---

[1] The programs were chosen by employing two measures; measure A (underling reading methods and objectives), measure B (simple aesthetic and usability), (see chapter 5 and appendix C).

is targeted at pupils who experience problems with developing and mastering reading. The content of the program is 150 words in total, divided into several levels. The reading method advocated by the Sentence Master Program is based on the over learning of words (the repeated learning of words; 40 to 50 trials of each word) i.e. the word.

Sentence Master links the diagnosis of reading problems to the intervention, based on using this program. It aims to overcome reading deficits in poor readers in the area of naming syntax and comprehension. Sentence Master is based on the philosophy that poor readers or people who have difficulty in learning to read have these difficulties due to the methods used to teach reading; these methods, according to Blank (ibid.), are based on naming and labelling. Blank maintained that people with reading disabilities or poor readers find it difficult to learn to read using these methods, as they require the recall and recognition of too many words, which puts a great strain on them. Sentence Master is based on different principles, as it advocates the recognition/mastery of words through learning the words repetitively until they are known.

New words are taught in four categories (word introduction, word recognition, sequential recognition and spelling; spelling was omitted from this study). The first part typically begins with layers of words in which a man on a construction platform rubs out with a brush on each click/touch of the words taught. The navigation of this program is done on each screen by the user. The response time can be set from one to infinite. The word taught is super-imposed on a button which is highlighted (to give users an indication of the word they should select from the list of words displayed on the computer screen). Audio commands instruct the child to select the word being taught; for example "select bus" or 'press a key to continue'. Sentence Master provides vocal prompts, such as "this is a bus" and "press a key to continue". Animation to reinforce the right response is included. The number of prompts given by the computer depends on the user clicking on the interface. The repetition ranges from 30-40 trials of the same word (see figures 3.2).



The child in this screen-shot is expected to select the word 'bus''

FIGURE 3.2: EXAMPLE OF THE "SENTENCE MASTER" INTERFACE

Typologies of the Computer Programs

The ‘Speaking for Myself’ and ‘Sentence Master’ computer programs belong to different typologies (see tables 3.1 and 3.2). The SM program is a learn-and-drill educational program. SM is a slow paced progressive program, where the user gradually progresses, from one level to the subsequent levels. The words are taught on varied levels where one level reinforces the word learnt at the previous level. The four levels are level 1: word introduction; level 2: word recognition; level 3: sequential recognition; and level 4: spelling.

The FM program is simply a multimedia-based educational program. It employs various tools to support learning to read and communication, including flash-cards, a video of a person signing and audio sounds and music. The four varied forms of reading include: single word activity, two and three word talking stories, nursery rhymes, and games.

TABLE 3.1: PROFILE OF THE COMPUTER PROGRAM FM		**TABLE 3.2: PROFILE OF THE COMPUTER PROGRAM SM**	
Main features present	Status/comment	Main features present	Number present
Type of program	Multimedia	Type of program	learn-and-drill
Teaching approach	Flash card whole word sight vocabulary.	Teaching approach	Over-learning over-training
Animations	limited	Animations	Present
Repetitions	absent	Repetitions	present
Prompts	absent	Prompts	present
Structure/ levels	4 activities	Structure/ levels	4
Number trails	absent	Number trails	40-50
Types of words taught	Various	Types of words taught	Content words[1] & non-content words[2]
Additional tools	Flash card, communication symbols, sign along videos	Additional tools	

3.2 THE UNDERPINNING THEORIES

Theories should guide research. The theories employed in this research are based on a combination of core and supplementary theories.

The core theories, applied in this research consist of four domains, which encompass learning (psychology), literacy (education) Human Computer Interaction (HCI) and software engineering. The supplementary theories consist of past studies, the data collection and findings. Table 3.3 at the end of this section illustrates these categories.

3.2.1 Core learning theories

This section aims to investigate the learning theories that should be applied to investigate appropriate computer programs for children with ASD, and how the programs in the public domain should be designed to suit the purpose of teaching early reading to children with ASD. The core learning theories discussed in this section are the essential subject area, which includes learning theories (Sutherland, 1992), ASD theories (Hill, 2004), early literacy (Bielby, 1994), HCI (Preece, 1993) and software engineering (Kichenham et al., 2000).

Learning

Learning, with reference to the field of psychology, is a hypothetical construct used to describe the process by which information is obtained (Gross, 1992). Cognitive psychologists and educationalists have contributed to this topic, examining issues relating to how children learn.

In educating children, it is essential to understand the learning and developmental issues that are involved in this process and the role that they play in learning and the acquisition of knowledge, as noted by Taylor (1996). An understanding of these issues will promote a grounded approach to teaching practice and, in the case of this investigation, to teaching children with ASD to read using ECP.

Before discussing learning in children with ASD, this investigation will examine learning in both typically developing children and children with learning disabilities.

Learning Theory in Typically Developing (TD) Children

Piaget gave the first systematic account of child development (Sutherland, 1992). He outlined a universal pattern of cognitive growth (development) for all children. His contributions to cognitive development upheld the view that a child's development is important to his/her learning. Piaget was of the view that, when educating a child, the child’s intellectual level should be taken into account. He recommended that a child should only be taught when she/he is intellectually ready to be stimulated. Many children who are at the severe end of the autistic spectrum may lack the stimulation that Piaget postulated. Autistic children need to be helped to learn, even if they appear to lack the stimulation to learn, as proposed by Powell (2001).

Piaget’s theory of repetitive behaviour stipulates that repetitive behaviour occurs if a child finds an activity pleasurable, which supports repetition in learning, as propagated by behaviourists, such as Skinner, cited in Sutherland, (1992). This theory is applicable to children with ASD who need some level of repetition to encourage their learning and improve their memory, as supported Simpson (2001), whose investigation into the Applied Behavioural Analysis (ABA) approach for children with ASD supports this ideology.

The problem with Piaget’s theory is that it reviews development in typically developing children. This research required a theory that takes into consideration ASD’s strengths and limitations (in the light of what can achieved in software development), that can be applied to the early reading theory (not only in theory but also empirically) and then to the design of appropriate computer programs for children with ASD.

Skinner, an American behaviourist, based his learning theory on the mechanism of operant conditioning, which is based on a reward system. Skinner showed how reward can shape behaviour. Skinner's approach views learning as a process to be controlled by teachers through a reward system (Sutherland, 1992).

The behavioural approach to rewards (based on conditioning) has been successfully incorporated into many teaching and intervention programmes for children with ASD (as discussed in the following chapters). Although this approach is a useful theory, as a key approach, such as repetition and the drill and practice approach, it may be effective in the design of ECP for children with ASD. However, it is the view of this investigation that a more integrated theory for ASD is needed.

Vygotsky (a constructivist[2]) states that, for learning to occur, it must result from the mutual interaction between the child and those with whom the child has regular contact (ibid). Vygotsky advocates a form of teaching in which the pupils are active learners. There is some substance to the theory that learning is an exchange or interaction; however, with regard to children with ASD, although interaction is important, children with ASD may prefer to observe than to interact. This theory, therefore, is limiting for these children, as was noted by Frith (1989), Wing (1996) and Powell (2000).

Bruner (a psychologist and educationalist) agrees with Vygotsky's view that the emphasis should be placed on the teacher's role. Bruner (ibid) is of the view that it is the responsibility of teachers to search for the pedagogical means of encouraging slower learners.

The teaching theory of ASD should involve, as part of its core ideology, the role of the teachers, who should play key roles in the intervention/teaching of children with ASD. Teaching/teachers play a role in encouraging learning that should be backed up by pedagogical practices, which are known to be employed in teaching children with ASD (see chapters 1 and 8).

Akin to Piaget's view, Vygotsky' theories of learning state that children learn from experience. The onus is, therefore, on the teachers to discover the conceptual level of each child in a class in order to make learning more meaningful to them. The constructivists believe that a child constructs his/her own unique set of concepts in order to cope with and explain the world around him/her. This may be the case for typically developing children; however, children with ASD need to be guided in their learning process (especially through their early years). As noted by Tjus et al (2001), children with ASD were frequently off-track in the given task. In an investigation into promoting communication and literacy skills in children with ASD, they found the children to be more attentive when a highly motivating multimedia environment was introduced to alleviate this problem.

[2] Constructivism is a psychological theory of knowledge which postulates that humans generate knowledge and meaning from experience.

However, unlike Vygotsky's theories of learning, Piaget postulated a fundamental aspect of learning, which is that a child will repeat actions that he/she finds pleasurable. Piaget postulates an environment in which a child learns by discovery. This postulation with regard to repetition is applicable to children with ASD (who have problems with information processing, as acknowledged by Powell and Jordan, 1997), although the postulation with regard to discovery through learning may not benefit children with ASD who may lack strategies for directing their learning, as noted in the LD Online Newsletter (2002).

Children with ASD find themselves in a world that they find confusing (as noted by Frith, 1989 and Wing 1996), so expecting them to construct their own unique sets of concepts to explain the world around them is unrealistic. The best the theory can advocate is to present the concepts or learning at the level of the child with ASD, as suggested by Peeters (2001).

Other problems with these theories of learning (discussed above) are that they predominantly focus on typically developing children. Children with ASD cannot be taught in the same way, as they suffer from conditions (including hyperactivity, attention deficit problems, information processing problems and communication problems, as noted in the Autism Independent UK (2008), Baron-Cohen et al. (1985) and Baron-Cohen (1993) that may prevent them from learning in a conventional manner. They need additional support and may need props to aid, support and accelerate their learning. The Piaget theorists, for instance, imply that children with learning disabilities will be in either the sensor motor or pre-operational stage. These theorists argue that teachers should teach children in this category as much as possible and thus accommodate their needs.

Persaud (2000) criticised this view, stating that, by labelling children in this way, we hamper their chances, as well as exclude and marginalize them from the concrete or formal operational stages (the stages of formal education), thus creating an atmosphere of low expectation.

An additional theory of learning considered (in trying to find a suitable learning theory for this research) is the cognitive psychologists' perspective of learning. Cognitive psychology examines the mental process by which knowledge of the world is attained and retained (Eysenck and Keane (1995). It covers issues that deal with attention, memory, perception and thinking, problem solving and others mental activities (Gross, 1992). Freud brought into the public domain the complexity of the human mind and the need to consider the human mind in terms of cognition, symbol manipulation, emotion and motivation. Cognitive psychology builds on the strengths of various schools of psychology (behaviourist), neuro-psychology, artificial intelligence and computer simulation (Eysenck and Keane, 1995).

Cognitive psychology proposes that human cognition is a complex process that involves a combination of cognition, behaviour and motivation. It combines the views of the psychologists with those of the behaviourists, and advocates an impartial scientific approach, whereas artificial intelligence computer simulation and phenomenology draw on people's subjective experiences.

In children with ASD, drawing on the children's subjective experiences, (as proposed above) may lead to distortion in what is taught or learnt due to the problems these children have with generalising and making inferences (see chapter 1).

The next sets of theories to be considered are in Human Computer Interaction (HCI). One of the hallmarks of HCI is to understand how people interact with computers; how knowledge is passed from computers to humans (Preece, 1993). Psychology and, in particular, cognitive psychology have influenced HCI in providing theories for modelling learning. Cognitive psychology forms the basis for understanding how to pass on knowledge using computing technology. The early cognitive psychologists attempted to explain the working of the human memory and build the first simplistic theory of cognition that could combat the problems of system design.

The Model Human Processor (MHP) models people as information processors with certain characteristics and abilities. It is a model that is proposed as a good practice guide for the design of computer systems. It focuses on the issues relating to mental activities, building issues related to learning (perception, affordance and memory) and the design of computer systems. It also models human abilities and the cognition processes involved in learning. Card, Moran and Newell's (1983) model of MHP (and later the extended MHP; Barber 1988) provides a simplified explanation of the human cognitive function. This model is composed of processors and memories and it predicts how a person responds to stimulus.

The idea of human processing postulates that information enters and exits the human in four stages; encoding, comparison, response selection and response execution (Lindsay and Norman, 1997). The MHP model provides the basis for the Goal, Operators Methods and Selection Rules (GOMS) technique proposed by Card, Moran and Newell (ibid) for the description of human task performance.

The benefits of the MHP in the context of this investigation include the application of information in various stages, and this approach, if applied to software development for children with ASD, may provide a 'bite size' for ECP, whereby information is taught in the smallest possible chunks in order to alleviate some of the information processing problems facing children with ASD.

The MHP approach can be applied to empirical evaluation in order to investigate whether or not the cognitive requirement of the prospective users are being met by determining their information processing capacity, one way this can be determined is by considering the levels of learning disability they might possess .

The MHP was criticised by Nardi (1996) for being a series of processes which may be inappropriate and/or too restrictive and simplistic. The MHP lacks the specialist perceptive needed to meet the needs of children with ASD. The MHP is too simplistic and lacks any real focus. What is needed is a theory that will provide sufficient depth to enable children with this condition effectively to employ ECP to learn to read, as the much needed specialist theory for ASD cannot be found in this theory.

The conclusion of this investigation is that the MHP can be applied to this research in addition to the other theories discussed below (also see the table below).

Other theories within HCI that can be employed in research include: the ambiguity conceptual framework, the mental model theory, distributed cognition (that stresses that distribution cognition is best understood in relation to the distribution between human and artefacts), activity theory as proposed by Luria Suh at al. (2003; that stresses the role of the socio-cultural context in interactions), and situated action theory (that stresses the need to pay attention to the concrete details of intelligent actions that reveal the limitations of human-machine interaction).

The activity theory is a descriptive theory which focuses on individual user goals/actions that are achieved through completing various tasks. Activity theory originated from the work of the German philosophers Kant, Hegel, Marx and Engels and the Russian cultural psychologists Vygotsky and Luria.

The activity theory was considered in this research, as the emphasis on achieving tasks/goals/actions may ensure that the task (which, in the context of this research, is the learning of new words by children with ASD using two computer programs) will be accomplished through the focused, detailed analysis and implementation of the task that this investigation considers.

This research discovered that applying the activity theory was not as straightforward as anticipated, as certain problems, for instance, the difficulty of applying this theory to the design of computer programs for children with ASD, became apparent, such as the problem of how the activity/action, for example ‘learning to read’, can be achieved in terms of turning the activities into practical achievable goals.

There is also the problem of applying this theory in a social context (as proposed in this theory. In what social context could learning to read be applied? Should it be applied to the national curriculum or is there other aspect of the social or cultural life of children with ASD that needs to be considered?

Another theory considered in this investigation is mental modelling. This theory states that, in the course of interacting with the environment and the world around us on a daily basis, we form a mental model of the things that we interact with, in order to facilitate later interaction with other aspects of our environment. Creating a mental model during previous interactions enables designers/developers or researchers to predict and explain past interactions (Preece, 1993). The user’s mental model of the computer system is the model that a user conjures from his/her past experiences of using a computer system. Using the mental model for ASD may prove problematic, as it will be difficult to determine an appropriate mental model (metaphor) for autism, as children with ASD, although they share some characteristics, such as liking bright colours, may have varied preferences regarding the colour to which they respond.

Learning theories in Children with Disabilities (as well as ASD; model for ASD)
The main learning theories focus on typically developing children. The studies in the public domain which reflect some of the needs of children with ASD include Vygotsky’s ideology, which stipulates that capable

children with special needs should be helped to acquire basic literacy skills, is unconstitutional and negates the children's civil right, as stipulated by the Disability Discrimination Act 1995 (Office of Public Sector Information, 1995); which dictates that all children need to be given the same opportunities. This view favours educating children with special needs, yet it also limits their potential. Children with learning disabilities should be given the freedom to learn as far as the individual is able without having limitations placed on how much they should be allowed to learn (ibid).

Another theory of learning in the psychology public domain applied to children with ASD is the conditional response (Pavlou, 1927) and operant conditioning (Skinner, cited in) applied to speech and behaviour in children with ASD (as stated by Lovaas et al, 1967). The conditional response approach stipulates that the combination of the Conditional Stimulus (CS) and the Unconditional Stimulus (US) will produce a behavioural response; Pavlou called these Conditional Reponses (CR) or learning. The problem with the conditional response lies in the fact that applying this approach to children with ASD will not necessarily lead to learning in these children due to the problems that they experience with information processing (as noted by Happe, 2001) and memory (as noted by Powell, 2000). The operant conditioning approach is based on a reward system (a behaviourist approach), whereby the child is given a reward of food (and later food and praise) in return for positive social gestures, such as speech. The problem with the operant conditioning approach is that it is a tedious and sometimes almost cruel approach that may be too stressful for the child. Some parents may find the rigorous approach close to being inhumane.

Other theories that favour the education of children with special needs are the constructivists' views. They advocate that teachers should identify the learning strategies that the child has mastered and build on these. The meta-cognition movement advocates that all children, including those with mental handicaps, should be made aware of their learning and of the language that they use. The behaviourists see the need for more structure and repetition in the learning and teaching of children with special needs.

The theories discussed so far do not suffice, and cannot be applied to learning in children with ASD who face challenges concerning perception and memory (along with communication problems, imagination problems and social problems).

Another theory that was considered as suitable to employ in this research is the Rare Event Learning Model (REL). Originally developed by Nelson et al. (1997), this is a cognitive theory-based model, which attempts to facilitate learning opportunities for children by providing the essential element that will encourage learning. The REL stipulates that the key to improving learning is to recognise that episodes of significant learning are typically rare because it is difficult to bring together multiple relevant conditions (Nelson et al 1997, 2001).A "Tricky mix" (combination) of conditions must occur in order for this to be achieved. Finding new ways to create learning opportunities through the effective convergence of multiple conditions is crucial to the success of child learning.

The theory proposed five conditions (known as the scheme LEARN) that need to be considered when designing multimedia computer programs for children with learning disabilities. They include the launching, enhancing, adjustment; readiness and network conditions Nelson et al (2001) defined these as follows:

- Launching conditions: This aspect focuses on the child's ability to recognize structures and to retain information in his/her long-term memory.
- Enhancing conditions: This aspect focuses on the availability of facilities that may enhance learning.
- Adjustment conditions: This aspect aims to reduce the amount of similar information and to help the child to process information in his/her working memory. It also encourages long-term memory.
- Readiness conditions: This includes the level of the child's performance which may be in the form of interest and motivation.
- Network conditions: This section involves an examination of how new structures are integrated with pre-existing ones.

The REL theory has been employed in previous studies that investigated using multimedia technology to support communication and literacy skills in children with and without disabilities (Nelson et al. 1997, Nelson et al. 2001, William et al 2002).

Tjus et al. (1998) employed the REL theory in an investigation involving 13 children with ASD, mixed handicaps and pre-school children, and recorded that children with ASD and various cognitive disabilities might benefit from a strategy that combines motivating multimedia programs and a positive interaction with the teacher. The authors tried to replicate and refine their previous theory about how children's cognitive language capacity influences their acquisition of a new language structure. The investigation examined ways of applying and optimising reading in children with ASD through a theory of learning and teaching strategies. The theory applied to children with ASD in this investigation is weak and lacks a detailed understanding of the ASD challenges (information processing and memory), problems and learning style; from his published work Tjus et al. appear to lack knowledge about applying computing technology to ASD.

Nelson et al. (1997, 2001) applied REL theory to the design of a multimedia literacy program to advance reading and writing in children aged 5 (beginning to read) and 10-16 year olds with varied disabilities, including ASD, deafness, motor disabilities, dyslexia, and ADHD (Attention-Deficit /Hyperactive Disorder). Nelson et al. (2001), in more detailed research involving children with ASD, language-delayed, deaf and other children, employed the REL theory to investigate the benefits of varied forms of communication devices in advancing spoken language, sign language, literacy and art skills. This investigation focused on combining the 'tricky mix' (REL), multimedia computers and a tutor to promote reading and language in ASD, deaf, and language-delayed children. This investigation is limited in terms of the scope that it would need to cover in order fully to uncover the problems in ASD (which has a varied scope, as it covers a wide range of the autistic spectrum) and to provide remedies that are applicable to the ASD condition.

Tjus and Heimann (2000) suggested that an educational strategy that includes enjoyable multimedia materials based on the REL (or LEARN) theory/approach will profit children with ASD in the area of language and communication. It was impossible to obtain a copy of the software employed in this research to examine its content and applicability to children with ASD, however, from the documents reviewed, it emerged that this research omitted vital issues that could help to advance computing technology; for example, insufficient attention was paid to the learning styles of ASD children, such as information processing and communication issues.

Williams et al. (2002), who evaluated the progress of 3-5 year olds with ASD in developing reading skills using computer assisted learning and book based learning, advocated the REL theory. The investigation noted that 5 of the 8 children who took part in the research identify at least three words through the use of CAL and that the children with ASD spent more time on the reading material when they accessed it through a computer and were less resistant to the use of this technology in their learning.

This investigation by Williams et al. (ibid) recognised the benefits of technology in assisting learning and trying to adapt learning using multimedia technology for children with ASD, but, as in the previous investigations (discussed above), it failed to address the pertinent issues relating to employing technology to teach ASD children, including information processing and memory problems in children with ASD. Other challenges to ASD children can be addressed by understanding and implementing the ASD learning style (ALS; see chapter 1 and ASD theory, below).

Nelson et al.'s (1977) investigation was beneficial as it examined both the Alpha program (for PC) and Delta Message (for Macintosh). A number of advances were made in this inquiry in the aspect of design considerations and the call for the greater incorporation of sign language and the spoken words into the system design, as suggested in this investigation. However, it is limited, as it failed to address issues relating to the memory, attention, limiting arousal and the emotional state of children with ASD.

Some of the benefits of the REL model (theory) include the fact that it focuses on consolidating the conditions under which learning is achieved by providing the structure needed for learning and consolidating what has been learnt. This theory, when applied, could provide the support needed for slow, moderate and rapid learners, by pacing the way in which children learn according to their needs and abilities.

The adjustment conditions, for instance, stress the fact that the need to motivate ASD children with motivational and attention problems is vital. The adjustment condition is an aspect of this theory that is of value to children with ASD. This condition stipulates that active steps are to be taken to ensure that attention and motivation are sustained, and the emotional needs of the children with ASD are important in developing computer programs or learning strategies for them.

Some problems found in the launching condition of the REL model can be attributed to the fact that it proposes that children, through recognising structure, will retain information learnt in their memory. Children with ASD have problems with their long-term memory; this condition expects a child with ASD to encode or retain difficult structures in his/her long-term memory for future use, which is not pragmatic.

In the enhancing condition, the facilities (see above) that should be made available to enhance learning to read, for instance, are not listed in this condition. This condition is too vague and may lead to misinterpretations about what is meant; for example, facilities can take the form of assistive technology or more reading materials.

The readiness condition was not properly explained. Although it acknowledged that the child's interest and motivation should be capitalised on, this condition fails to suggest how this can be achieved. How is the child's prior knowledge incorporated into the new aspect learnt?

In the network conditions (which involves an examination of how new structures are integrated with the pre-existing ones), the use of the term 'structure' is vague and can be misconstrued as the overall educational structure of the child or the task being taught or leant.

Some of the problems with the REL theory are that it fails to draw on the learning theories that would have provided it with the grounding needed to support it. The REL theory used the word 'learning' in a vague manner, without defining to which aspects of learning were being referred, thereby making this theory difficult to apply.

Another problem with the REL theory is that, although it recognises the benefits of technology in assisting learning and adapting learning using multimedia technology (for example, in Nelson et al.'s (1977) studies key issues were not adequately addressed; for example, those relating to memory, attention, hyperactivity and the dispositions of children with ASD.

Theories focusing on the ASD challenges may provide the much needed learning theories to form the basis of a learning theory for ASD. These theories (discussed above), although they are of some benefit for educating children with disabilities, are, however, limited when applied to the learning and development of children with ASD. A clearer understanding of ASD is needed to assist the education of children with this condition and determine how they can benefit from the use of computer technology.

Autistic Spectrum Disorder (ASD) Theories

ASD is characterised as a collection of neurological abnormalities, such as arousal over-sensitivity and problems, behavioural abnormalities, such as hyperactivity and attention problems, and learning disabilities. In trying to educate a child with ASD, it is vital to take all of these factors into account. Any theory of learning for children with this condition must reflect the details of a strategy for combating/moderating some of the learning problems of ASD. Little work has been carried out on ASD and relevant learning theories.

A common problem shared by children with ASD is the 'triad of impairment'. This consists of communication, imagination and socialisation problems (Wing 1996). These problems impact on the learning in children, as they hinder their ability to communicate with others in a meaningful way and to use their imagination in tasks that involve them being creative and understanding other people's emotional states.

The four main theories of ASD, which explain the characteristics and learning approach/theories for children with this condition, are the weak central coherence, executive function, theory of mind and executive dysfunction theories.

Central coherence theory refers to the information processing style in ASD, which specifically relates to the tendency for children with this condition to process incoming information in its context (the tendency to process contextual meaning piece-meal). Problems of central coherence include rigidity in thinking.

Happe (1999) introduced the premise for the theory of autism based on the theory of 'weak central coherence', and argued that the theory of mind and executive function explanation does not explain the strengths of this condition in areas such as being skilful in completing complex tasks, such as jigsaw puzzles, or other savant skills, such as painting or music. This theory, when applied to ASD and ECP, shows that the strengths and weaknesses in ASD children can be emphasised or minimised by including adaptable features in the computer program (see chapter 8).

The executive function is found to be limited in children with ASD. Problems with their executive function may affect their planning, mental flexibility and inhibition. Hill (2004) observed that the problem with executive function can be attributed to the dysfunction of the brain. The theory highlights the issues of the information processing problems in ASD and makes some suggestions about how to combat some of these problems. For example, executive dysfunction problems may be helped by prompts and by providing structure in the ECP as well as a routine for the use of the technology (see chapter 8).

The 'Theory of mind' accounts for ASD problems related to obsessive, rigid and persevering behaviour. It refers to the ability to manipulate and understand that certain attributes, such as beliefs and desires, are both lacking in people with ASD. Tests conducted that buttress these problems are the Sally and Ann belief test (Baron Cohen, 1985, 2002). Baron Cohen (2006) noted that children with ASD are strong 'systemizers'.

The 'theory of mind' postulates that people with ASD lack the ability to attribute the same mental state to others as they apply to themselves; i.e. to make inferences. Baron-Cohen et al. (1985) focused on testing the hypothesis that children with ASD have no 'theory of mind'. Baron-Cohen et al. demonstrated that the children often find it difficult to appreciate that another person might have a different perspective or even different knowledge about a situation or task. For example, they may be told a story about a character (Sally) who puts her doll into a box and then leaves the room. Unknown to Sally, another character then moves the doll to another location. In subsequent questions, they may make mistakes about what Sally knows about the location of the doll, thinking that she knows what they know, even though they can answer other questions of equal difficulty correctly.

The theory of mind or "mind blindness", as it is sometimes known, manifests itself in inherent problems which include:

- Problems of generalisation
- Deficiency in the understanding of pretence and irony (literal interpretation of language)

- Lack of ability to make inferences (i.e. cause and effect).
- Inability to make mental judgements
- Cognitive problems and their effect on social skills and learning (as was found by them failing the belief question).

The theory of mind, adopted as a learning theory for this investigation, postulates the emphasis on Autistic Learning Style (ALS) which stresses the key information processing aid (assistive technology devises) which emphasises visual learning and repetition (see chapter 8)

The executive dysfunction explains some of the behavioural problems; this includes problems with rigidity (the tendency to get stuck on a task), lack of initiative (planning problems) and problems with working memory. Executive dysfunction theories account for some of the social problems in ASD, accounting for problems with planning, memory and imitation, to mention a few. This is linked with damage to the frontal lobes, as found in brain-damaged patients and people with congenital defeats. Tests conducted that buttress these problems include the 'Go / No Go', implemented by Ozonoff et al. (1994), and the stroop task test (Stroop, 1935), as examined by Hills and Frith (2003).

The ASD theories have been discussed above. The next task is to investigate the reading theories in the public domain in order to determine the best reading approach to employ with children with this condition.

3.2.2 Reading theories

In this section, the theories of reading in typically developing children are discussed, followed by a discussion about how children with ASD are thought to learn. These theories are applied to the methodological framework of this investigation.

The methods employed to teach reading in typically developing children include the traditional, look-and say, alphabetic and phonetic methods. The processes employed to teach reading are the content and syntax, phonological, semantic and comprehension processes.

The content and syntax approach is concerned with the factors that influence the interpretation of the meaning of words (content). Syntax is the aspect of grammar that is concerned with the way in which words are ordered. Content and syntax processing requires the reader to select the appropriate response from a range of possible responses activated by the orthographic form (whole language) of the word (Bielby, 1994).

The phonological process or the phonological teaching of reading encompasses the learning of sounds in words and how they relate to reading (see chapter 8 and the glossary for details of reading approach). It refers to the function of the auditory system that identifies and processes sounds as well as sound patterns that are linguistically meaningful. The orthographic process refers to the spelling of words. This process is often called decoding, which is the process of building up words from letters. Semantics deals with the meaning of words, and the methods by which words are built up into sentences (ibid).

These methods are employed as follows:

The traditional/whole language method

The traditional or whole language method focuses on the need to identify words before meaning can be constructed from them. This method primarily uses flashcards as a medium to teach reading. This process typically stresses that, when a child learns to read, he/she sees only black dots or dotted lines on the page. Later, the child begins to see the black dots as letters and, finally, as words. This is achieved through a process commonly known as rote learning.

This method begins with the child reading whole words, and finds theoretical support from Goodman and Goodman (1979 cited in Sutherland 1992). The child then reads a sentence, gaining an understanding of the words from the content, pictures and objects. With this method of learning to read, the semantics of the word are highlighted, and the children learn the meaning of the word first.

The alphabetic method

The alphabetic method involves teaching reading by decoding letters into sounds; for example: caa /aa /taah/ spells cat.

Phonetic method

Phonetics involves the relationship between the sounds and writing system of a language. It is a method of teaching reading by encouraging children to sound out letters and blend the sounds together; for example: /m/ -/aa/ -/t/ in the pronunciation of mat. Bryant and Bradley are advocates of this method but express reservations about the old phonic-drill approach (ibid).

How children with ASD are taught to read

There is no consensus on how children should be taught to read. Most of the methods discussed above are employed across the board to teach typically developing children. For children with ASD, there is no established forum to consider or promote the best ways of teaching these children to read. The existing methods may be effective for some children without cognitive problems but not for children with ASD.

Children with ASD are taught to read using the same conventional methods as those used for other children. These include the alphabetical, phonological and traditional approaches. These methods are based on the National Curriculum for Special Needs in Schools (P level).

Discussed below are some of the reasons why the typical or conventional/mainstream reading methods are unsuitable for children with ASD.

Bielby (1994) stated that children under adult guidance and instruction can teach themselves to read. This author stresses that, when children begin to read, their knowledge of language is the spoken word, and learning to read is initially a matter of relating this written language to their existing knowledge. However, children with ASD and SLD may not have the ability to employ spoken words in order to learn to read, as a significant proportion of younger children with ASD are non-verbal, and may express themselves in other ways; for example by touching, pointing or using the Picture Exchange Communication System (PECS), as proposed by Bondy and Frost (2001) and the National Autistic Society (2008g), and may manifest abnormalities of speech, such as echolalia or mutism, as observed by Siegel (2003), Damasio and Maurer, (1978), so this advocated method is unsuitable.

Children with ASD may learn purely from their exposure to whole words, as advocated by the whole language approach. Williams et al. (2002) noted that computer-based instruction was effective in teaching children with ASD to read. Murray (1997) suggests that the exposure to texts and the potential to survey them at the child's leisure using technology, such as computers, can motivate a child with ASD to develop reading skills. Temple (2002) supported this assertion. This proposal was confirmed by Heimann et al (1995), who reported a significant gain ($p<.05$) in the number of words learnt in children with ASD in research that investigated reading and communication in children with ASD, disabilities and pre-school children.

The alphabetic method is the method of teaching reading by decoding letters into sounds. This method may be suitable for children without disabilities but may be challenging for children with ASD and severe learning disabilities. They may lack the cognitive abilities to be able to decode words or have difficulty in making connections and categorising what they have been taught (Powell, 2001), as well as severe oral-motor apraxia (control of the mouth, lips and tongue), and an inability to sound out words (Damasio and Maurer, 1978).

Similarly, the application of this method with some non-verbal children with ASD may prove problematic, as they may lack the strategies for decoding words, as children with ASD have difficulty understanding the relationship between sounds and meanings, as noted in an investigation by Temple (2002) and Vacca (2007). Vacca’s ten proposals about how to teach children with ASD to read had the basic theme that applying the ASD learning style should be a key factor that must be considered. Temple provided a list of good practice tips for teaching children with ASD.

Akin to the alphabetic method, the phonic method, explained above, may not be suited to children with ASD and SLD. This is due to cognitive problems and a lack of vocal abilities alongside an inability to use strategies to associate sounds with the writing system of a language. It can be argued that the use of phonics is impractical for the teaching of children with ASD and especially those with SLD who are non-verbal. This is contrary to the findings of Heimann et al. (1995), who noted that the intervention of motivating multimedia as well as planning and monitoring by teachers, parents and clinicians will increase both reading and phonological awareness in children with ASD, as reported in this investigation.

Reading approach for ASD

The recommended learning approach for teaching children with ASD new words should include a combination of the whole language approach and the autistic learning style strategy, which is focused on visual learning and repetition (discussed in 8). The use of whole language will be most suited to the teaching of new words to children with ASD, as it focuses on autistic learning style (see chapter 1).

As some of the findings of this research (the interviews) indicate, children with ASD will benefit from a learning strategy that capitalises on the fact that it involves visual learning. Due to the problems that they have in learning, employing one of their strongest assets to promote the learning of new words will be of benefit. At a later stage of the learning process, the phonics approach could be gradually introduced as an addition to this strategy. This should be introduced gradually, as the complexity of this strategy in learning to read words from the way they are pronounced or sound may be too complex for many children with ASD.

Learning and reading theory for ASD

Based on the investigation above, the underpinning methodology for learning to read in children with ASD should be based on the four main theories of the deficiencies and strengths in ASD and the learning and reading theory (discussed above) to suit the autistic child. A specialist theory for ASD is developed in table 3.3.

TABLE 3.3: REVIEW OF THE LEARNING THEORIES APPLIED IN THIS INVESTIGATION

THEORIES	CONTEXT OF THE APPLICATION	WHERE IT SHOULD BE APPLIED
ASD theories Executive function Theory of mind Weak central coherence	Managing/reducing problems in ASD	These theories (executive function, theory of mind and weak central coherence) can be applied to combat information processing and behavioural problem whilst the child employs Educational Computer Program/s (ECP) to read; see chapter 8.
Learning theories Behaviourist Constructivist Cognitive psychology	Addressing the issues/problems of a child with ASD that the program needs to address (for example, problems with interest, motivation and attention)	This can be applied by : -Employing a reward system in the ECP - Employing the drill and practice approach in ECP - Employing repetition in the ECP
Reading theory Whole word	Whole word (focused on the visual teaching of reading)	Applied to the words taught
HCI Activity theory MHP	Focus on determining: -The task (volume and) capacity -The child's action (what the child needs to do: for example, click on the mouse or touch a button on the screen)	Integrating the tasks and actions in the program

3.3 METHOD

The empirical evaluation method was employed in this research. A made-to-measure approach combining qualitative and qualitative data collection tools was adopted in order to promote the research rigour, validity and reliability. This was achieved by employing experiments to test if the children will learn new words using two computer programs (empirical investigation i). The children were later observed using the programs in a separate study (empirical investigation ii), providing a direct way to obtain first-hand information about how the children interacted with the programs (by measuring predetermined behaviours; see chapter 5). Attitude questionnaires were completed by the teaching assistants and HCI professional to obtain positive and negative attitudes on the computer programs (empirical investigation iii), to highlight the benefits and limitations of the programs This method was complemented by interviews (empirical investigation iv) which provided in-depth information regarding the attitudes found in the previous empirical investigation, as well as recommendations on how the evaluated software can be improved. All of these methods provided some the materials employed in the development of design standards for literacy educational computer programs for children with ASD.

The method employed was implemented in three phases; the first phase (the initiation phase) involved reviewing the literature, planning, and design. The second phase involved the data collection, and the third phase discussed other considerations examined in this investigation.

3.3.1 Initiation phase 1

The literature was gathered and reviewed in order to position this investigation within the context of the previous research. The planning and design of this investigation then followed (with the adoption of applicable methods and the addition of other methods, where required). All of the approaches (the underpinning methodology and the methods of data collection) employed were examined closely to determine their suitability and appropriateness for the task of designing appropriate computer programs for children with ASD. A formal assessment of the methods employed now follows.

Methods employed in Related Studies

The approach or methods (data collection and analysis) employed in this research are based on a combination of methods adapted from relevant studies, such as those by Alcalde et al. (1998), Tjus et al. (1998), Heimann et al. (1993, 1995), Moore and Calvert (2000), Williams et al. (2002), Grynszpan et al (2005) and Kitchenham et al. (2002), discussed below, which were employed due to their similarities with the current research, and due to the fact that they provided a foundation for this research, from which it can extend its scope.

Related studies

One of the earlier studies that influenced the research method employed in this research is that by Alcalde et al. (1998), which adopted the quasi-experimental approach. The current research tried to understand and remedy some of the problems that children with learning difficulties face when using computer technology to learn, as noted in Alcalde et al.'s investigation, which advocated the Gagne theory[3] of learning, which was employed in the design and development of the computer program used in the test, although the scope of this investigation (involving all aspects of intellectual disabilities) meant that it did not pay adequate attention to any specific area within the ASD spectrum, which ranges from mild to severe disabilities. Alcalde et al. (1998) noted that it is important to examine the effectiveness of the computer program but failed to investigate the appropriate use of computer programs for specific groups, as in the current research.

Tjus et al. (ibid) undertook similar research involving 13 children with ASD and mixed handicaps and pre-school children, and recorded that children with ASD and various cognitive disabilities might benefit from a strategy that combines a motivational multimedia program and positive interaction with the teacher. In a quasi-experimental investigation, the authors recorded that reading became more rapid following the intervention in all of the children. The sample of this investigation, as in the current research, was small, involving only 13 children, and the tests used by Tjus et al. were based on chronological age, mental age and language age, which were unavailable in the current research.

Tjus et al. (ibid) employed the REL theory and concluded that it is a rare event to have all of the relevant and enhancing factors present to maximise learning. The authors tried to replicate and refine their previous theory about how children's cognitive language capacity influences their acquisition of a new language structure.

Heimann et al. (1993), in the DELTA Messages Project, a preliminary research, evaluated the impact of multimedia procedures in facilitating the acquisition of reading, writing and overall communication skills in children with significant delays in their communicative development. Moreover, Heimann et al. (1995) undertook another quasi-experimental investigation into the effects of employing an interactive and child-initiated microcomputer program (Alpha) for teaching reading and communication skills to three groups of 30 children (11 children with ASD (9 boys amd 2 girls), 9 children with mixed handicaps and 10 normal pre-school children), exploring the varied mediums of learning and communication. This investigation, unlike many other studies employed a larger sample (for example, Tjus et al. (1998) used 13 children, Moore and Calvert (2000) 14 and Williams et al. (2002) 8). The methodological approach employed in this investigation is similar to that of the current research. This research by Heimann et al. (ibid) provides our current investigation with an initial understanding of and methodological framework for how to conduct research into reading, computers and children with disability.

Heimann et al.'s (1995) research, discussed above, highlights the lack of well-designed experiments in previous studies in this field and the lack of solid data regarding the effectiveness of using computers with children with ASD. The research by Tjus et al. (ibid) also notes the importance of professional input into the design and implementation of computer programs for children with ASD, but fails to explore in-depth the issues of information processing and autistic abilities (strengths) and disabilities (weaknesses), or how these were addressed by the program and in the research.

---

[3] The Gagne theory of learning of instruction postulates that learning occurs under three conditions, focusing on learning outcome, the conditions of learning and the events of instruction.

One limitation of Tjus et al.'s investigation is that it combined diverse disabilities and so it is impossible to provide more depth. A more specialist investigation is needed to address the issues that are peculiar to children with ASD, such as those relating to the "triad of impediments" and how these are addressed in the computer program. This is what this current research aims to address.

Moore and Calvert (2000) explored issues relating to using computer programs to teach vocabulary in children with ASD. The research compared the use of computer programs with the use of behavioural programmes (employed by the teachers). The object labelling drill method was employed in the experiment. The authors also examined the integration of computers in the classroom to supplement pedagogical practice. The findings of this investigation recorded more attention, motivation and words learnt in the educational computer program condition than in the behavioural condition (where the teachers taught the children). This investigation was useful for giving direction to the current research, although its benefits were methodically limited.

Williams et al.'s (2002) investigation is another methodological influence on the current research. It evaluated the progress of 3-5 year olds with ASD in developing reading skills, using computer-assisted and book-based learning. The method employed in Williams' research is based on the instructive case study approach. This work influenced this investigation, as the issues examined are similar; this research investigates the most effective medium used to teach children with ASD to read CAI or PI (personal instruction). The significance of this investigation lies in the fact that it provides a framework for the current research.

This research by William et al. (ibid) explored the benefits of employing visual stimuli and combinations of text, sound and images, as suggested by Trehin in the LINK Autism-Europe (1994). The methodological gain was limited. However, other vital issues that could help to explore this technology further were ignored in this investigation, such as the learning styles of autistic children, information processing and communication issues.

Grynszpan et al.'s (2005) research investigated the use of computer software in the domain of social dialogue understanding and spatial planning, and monitored the progress of 8 ASD teenagers. This investigation made some important additions to the claim that CAL benefits people (in the domain of social dialogue understanding) with ASD but failed to develop a methodology to facilitate the design of such systems. It likewise failed to discover whether or not the use of varied output modalities impacted on the participants' learning.

Kitchenham et al. (2002) Guidelines for Research into Software Engineering

Kitchenham et al.'s (2002) guidelines were employed to facilitate the planning and implementation of research into software development. Their framework is discussed below under 7 sub-headings: experiment context, experiment design, conducting of the experiment and data collection, analysis, presentation of the results and interpretation of the results.

Experiment Context

C1: 'Be sure to specify as much of the industrial context as possible. In particular, clearly define the attributes and measures that are capturing the contextual information.'

The industrial context of this investigation is based on education, disabilities (ASD) and computer development. The stakeholders in this research are children and professionals in ASD (educationalists and therapists), software designers and the parents/guardians of children with ASD.

This research investigates how to improve ECP for children with ASD. The attributes and measures to be applied in the current research are discussed in the form of four empricial studies (discussed in detail in subsequent chapters). Empirical investigation i is based on the experiment (pre- and post-testing); empirical investigation ii is an observation/video recording; empirical investigation iii employs attitude questionnaires; and empirical investigation 4 conducts interviews.

Below is a summary of the 4 empirical studies, their attributes and the measures applied:

Empirical investigation i: Experiment (pre- and post-tests)

The attribute of the experiment is a pre-test treatment and post-tests. The measurement in this method is intended to determine of the number of words learnt by the children with ASD before and after the treatment (using 2 computer programs).

Empirical investigation ii: Observation/video recording

The observation/video taped investigation involves two sets of children: children with ASD and Typically Developing children (TD). The measures in this condition are based on measuring 3 behaviours: attention, motivation and engagement.

Empirical investigation iii: Attitude questionnaire

An attitude questionnaire was employed to obtain the attitudes of the participants (educationalists and HCI professionals) towards the two computer programs in 4 categories; usability, content/structure, learning style and general.

Empirical investigation iv: Interviews

Interviews were employed to solicit the views of the participants (educationalists and HCI professionals) about the two computer programs. Three measures are applied here: positive features, negative features and recommendations.

C2: 'If a specific hypothesis is being tested, state it clearly prior to performing the study and discuss the theory from which it is derived, so that their implications are apparent.'

The research questions/hypotheses investigated are directly linked to the four empirical studies:

<u>Research question A</u> (the main course of the investigation)

'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'

Research question B

This additional questions /hypotheses include:

(Empirical investigation I)

H1 (empirical investigation I) Educational computer programs ('Speaking for Myself'/'Sentence Master') will increase the number of words learnt in children with ASD.

(Empirical investigation ii)

R1: Can an educational multimedia computer program sustain the attention of children with ASD?

R2: Can an educational multimedia computer program motivate children with ASD?

R3: Can an educational multimedia computer program engage children with ASD?

AND

(H1) The looking/sustained attention will be less when children with ASD use a computer program containing little/no animation.

(H2) External prompts (computer, physical and verbal prompts combined) will be needed to keep children with ASD motivated. In essence, the more prompts, the more touching will occur.

(H3) Episodes of boredom and stress and lack of engagement will be greater in children with ASD when using a computer program with high levels of repetition.

(Empirical investigation iii)

(H1) The computer program is functional (easy to use/by implication, sustains attention)[4] for children with ASD.

(H2) The content and structure of the computer program is suitable for children with ASD.

(H3) The computer program will support the learning style (sustain attention, motivation and engagement) of children with ASD.

(H4) The computer program will promote a positive user experience[5] in children with ASD.

(Empirical investigation IV)

R1- 'How can Educational Computer programs (ECP) be improved to support learning to read in children with ASD, with reference to the two ECPs ('Speaking for Myself' and 'Sentence Master') investigated?'

---

[4] Functional means that the computer program should be easy for the learners to use and learn who, in the context of this study, are children with ASD.

[5] Positive user experience in the context of this study means that the users' have enjoyable encounters/experiences whilst using the computer program.

The theories that influenced these research questions/hypotheses are; ‘core theories (which are the main theories) based on four domains which includes, learning (psychology), literacy (education), HCI) and software engineering. The second consist of past similar studies (literature reviewed) and Kitchenham et al. (2002); guidelines on conducting research in software engineering.

C3: ‘If the research is exploratory, state clearly and, prior to the data analysis, what questions the investigation is intended to address and how it will address them. Why was this guideline not applied?’

As this investigation is exploratory, the research questions/hypotheses are clearly stated and the questions that the investigation aims to address and the method of implementation are defined prior to the data analysis (see chapter 1).

C4: ‘Describe research that is similar to, or has a bearing on, the current research and how the current work relates to it.’

Question C4 is discussed in section 3.2.

Experiment Design

D1: ‘Identify the population from which the subjects and objects are drawn.’
The research is based on 5 children with ASD in a special school and 5 typically developing children in an after-school club. The research sample is small, due to the vulnerable disposition of children with ASD and the severity of their learning and behavioural problems.

D2: ‘Define the process by which the subjects and objects were selected.’
The participants were selected randomly. For the ASD children, two special schools were approached for the investigation. There were not enough recruits from the second school, so the first school alone was employed in the investigation.

D3: ‘Define the process by which the subjects and objects are assigned to treatment.’
No special order was maintained in the allocation of the participants to treatment. All of the main participants (children with ASD) were given treatment (learning to read using both computer programs).

D5: ‘Define the experimental unit.’
The experimental test was employed in one of the four empirical studies. This test was not fully defined, as it is a quasi-experiment. There was a random application of participants for treatment, as the sample in the test was small, and due to the difficulties of recruiting participants, as well as the problem of how to manage the participants, given the special characteristics and disposition of children with ASD.

D8: ‘If you cannot avoid evaluating your own work, then make explicit any vested interest (including your sources of support) and report what you have done to minimize bias.’

The issue of bias was considered in this investigation and adequate care was taken to prevent it from affecting the investigation. The data gathering, analysis and reporting of the results were done as accurately as possible in order to minimise bias.

A reliability check was conducted during the observation investigation (empirical investigation ii; see chapter 5) to ensure that the research is objective and can be replicated. The reliability of the coding system is crucial to the success of the observation method (Bakeman and Gottman 1987). This technique was applied by comparing the coding of two observers and correcting for chance agreement. The inter-observer agreement is computed (on 20% of the data minimum) and analysed.

D9: 'Avoid the use of controls unless you are sure that the control situation can be unambiguously defined.'
This investigation upheld guideline D9, avoiding introducing a control in this treatment (investigation), due to the special characteristics and disposition of the children with ASD (see D5 above).

D10: 'Fully define all treatments (interventions).'
The treatment was applied only to children with ASD, since they are the focus of this investigation. The treatment sessions lasted 10-15 minutes, and there were 8 sessions in all. The treatment was in the form of two computer programs employed to learn new words.

D11: 'Justify the choice of outcome measures in terms of their relevance to the objectives of the empirical study.'

This evaluates the effectiveness of two computer programs in teaching new words to 5 children with ASD and requires the outcome measures to be measured empirically for objectivity.
Objectivity is taken to refer to what multiple observers agree is a phenomenon, in contrast to the subjective experience of the single individual (Robson 2002). The epistemological approach adopted in this investigation is based on combining the objective and subjective approaches, as advocated by the Positivist (quantitative) and Interpretivist (qualitative) paradigms (Blaikie, 1993). This process involves triangulating two methods of obtaining knowledge, one based on fact (objective knowledge) and the other based on experience (subjective knowledge). The benefit of this process is that research conducted in this way would produce a balanced approach to the method by which the investigation is conducted, by balancing the two forms of knowledge in the investigation.

This inquiry advocates the epistemological position based on empirical verification (by conducting pre- and post-tests) and knowledge based on opinions (by soliciting the views of the research participants/facilitators).[6]
The issues that need to be deliberated on include the choice of data gathering process and procedure in order to determine whether these tally with the type of knowledge advocated in this investigation (which is a

[6] The teaching assistants in the study were employed as facilitators; further discussion on facilitators can be found in subsequent chapters of this thesis.

combination of objective and subjective knowledge). For example, in this research, the qualitative research technique is exploratory and based on a subjective epistemological standpoint, so it employs techniques like interviews, which involve obtaining people's experiences, views and opinions. On the other hand, it advocates using objective-based knowledge to try and eliminate bias, by employing statistical-based, quantitative techniques. The qualitative and quantitative approaches are combined because they give this investigation a balanced perspective.

In addition, another benefit of combining objective and subjective knowledge and data collection methods (qualitative and quantitative) are that this facilitates the research, giving it a more rounded, robust perspective. It also promotes rigour and gives clarity to the research findings. For example, triangulating the data obtained from the pre- and post-tests by interviewing the facilitators (the classroom assistants) helped to shed light on the grade changes of the subjects. It may emerge during the interviews that the child had not had sufficient sleep the night before and this may have affected his performance in the test. In this case, if this investigation were implemented based solely on objective-based knowledge, which is based on quantitative techniques, the validity of my results would have been in dispute.

The empirical case by case strategy (the data collection was based on four empirical studies, covered in chapters 5-7) employed both qualitative and quantitative techniques. This involved combining two data collection techniques; qualitative (interviews) and quantitative (experiments, attitude questionnaires).

Conducting of the Experiment and Data Collection

DC1: 'Define all software measures fully, including the entity, attribute, unit and counting rules.' The software employed in this research is listed below (along with the empirical studies where they were applied).

- Empirical investigation i: (experiment) software employed 'Speaking for Myself', 'Sentence Master'
- The measures applied were the number of words learnt.
- Empirical investigation ii: (observation) software employed 'Final Cut Pro'.
- Empirical investigation iii: (attitude investigations) software employed SPSS[7] (for calculating the mean and frequency of the attitudes).
- Empirical investigation iv: (interviews) software used Nudist 6.
- More details about the software employed and the measures are listed in each chapter and in the appendix.

DC5: 'For observational studies and experiments, record data about subjects who drop out from the studies.' All of the participants in the ASD group participated in the treatment; however, not all of the participants were present for the pre- and post-testing (see chapter 4). All of the other participants in the other empirical studies took part in the studies.

DC6: 'For observational studies and experiments, record data about other performance measures that may be affected by the treatment, even if they are not the main focus of the study.'

[7] Statistical Package for the Social Sciences, used for statistical data analysis

The factors that could have affected the pre- and post-test results (empirical investigation i), other than the two computer programs, include that possibility that the children have learnt the words from lessons in the classroom previously.

In empirical investigation ii (observation), the view of the camcorders was sometime obstructed and, since the researcher had to co-ordinate the video recording session as well as operates one of the camcorders, some of the recording was unfocused; therefore, this investigation could not be completely free of other influences.

Analysis

A4: 'Ensure that the data do not violate the assumptions of the tests used on them.'
The data analysis was applied with all the measures fully applied (see chapters 4-7).

Presentation of Results

P2: 'Report the statistical package used'.
The statistical packages used include SPSS, Microsoft Excel and Nudist 6 computer programs for analysing the data collected.

P4: 'Present the raw data whenever possible. Otherwise, confirm that they are available for confidential review by the reviewers and independent auditors.'
The raw data are made available in the chapters where appropriate. Additional data can be found in the appendices or can be provided on request.

P5: 'Provide appropriate descriptive statistics.'
Descriptive statistics in the form of diagrams and graphs were employed in this inquiry.

P6: 'Make appropriate use of graphics.'
This investigation uses appropriate graphs, tables, and diagrams to display its findings.

Interpretation of the Results

I3: 'Define the type of study'.
This investigation is an evaluation inquiry, whereby the products (two computer programs) were evaluated in order to determine their suitability for use in learning to read in children with ASD. Four empirical studies based on varied data collection methods (experiment, video recording, attitude questionnaires and interviews) were employed.

I4: 'Specify any limitations of the study'
The limits of the research method and underpinning methodology are discussed in subsequent sections and chapter 8. In summary, this investigation was a difficult to conduct since it needs more manpower and participants. However, due to it being a PhD research, there was a financial and time limitation, as well as a lack of manpower to facilitate the planning and implementation of the research.

As, in the course of this investigation, it was identified that there was no systemic ways to design and implement studies in software development, this guideline provides a structured, direct and rigorous approach to planning, designing and implementing this research.

The guidelines provided create a framework, which is limited in that it does not provide the specialist knowledge needed to research this topic.

In the context of this investigation, Kitchenham et al.'s (2002) guidelines were informative and helpful in the planning and implementation of the research methods (data collection). However, some of the guidelines were redundant and irrelevant to this investigation. The guidelines omitted pertinent issues and, as this investigation focuses on a specialist topic, more specialist consideration of the participants and of ASD children, the subject of the research, is required.

3.3.2 Data collection phase 2

This phase involved the implementation of the four empirical studies, listed below:

Pre- and post-testing (empirical investigation I)

The experimental tests (pre- and post-tests) provided this investigation with avenues for measuring the number of words learnt by the subjects both before and after the introduction of computer programs designed to teach unknown words. The test conducted in the research is centred principally on the pre- and post-testing of the research subjects (5 children with ASD) to measure the words known before and after the intervention process.

Observation (empirical investigation ii)

Video recording was employed in this investigation as a data gathering tool to measure the experience and interaction of the subjects when using the two programs. The video recording/observation was employed in empirical investigation ii (see chapter 5). The observation was conducted in two phases, with two groups of children: typically developing children and children with ASD. The analysis of both sessions will give some indication of the child's user experience based on predetermined measures.

A key arrangement to stress is the typology of the video recording sessions. Two camcorders were employed: one was mounted on a high cupboard and recorded the child using the computer program (child-focused), whilst the other was hand-held by the researcher and focused on recording the child's activities when using the computer programs (screen-focused; see figure 3.3 below). The problems and limitations of these recording are discussed below.

FIGURE: 3.3 TYPOLOGY (A AND B) OF THE LAYOUT OF THE VIDEO RECORDING

Typology A

Camcorder A
Mounted on a large cupboard to record the participants' expressions and dispositions

A child using the computer program

Typology B

Camcorder B
Hand-held by MURASD researcher to record actions and activities on the computer screen.

Attitude questionnaires (empirical investigation iii)

Attitude questionnaires were employed in empirical investigation iii (see chapter 6). Questionnaires were employed as a data gathering tool to obtain the attitudes of the facilitators (the teaching staff who took part in this research) and the HCI professionals towards the computer programs employed in this investigation. The attitudes questionnaires (see appendix C) are based on 25 items using the Likert scale responses of strongly agree, agree, disagree and strongly disagree.

Interviews (IV)

Interviews were conducted as a vital part of the data gathering process (see empirical investigation iv in chapter 7). The interviews provide avenues for understanding the issues that may have arisen in the test and questionnaire completion sessions. The interviews provided a method for collating information from the perspective of all of the participants regarding the two computer programs evaluated.

Table 3.4 below gives an outline of the varied data collection methods, their purpose, method of analysis, the type of method involved and the hypotheses/research questions that it aims to address.

TABLE 3.4: DATA COLLECTION AND ANALYSIS

DATA TYPE	PURPOSE	ANALYSIS AND REPORT	TYPE OF DATA	HYPOTHESIS/ RESEARCH QUESTION/S
Video recording	To measure actions/ observe children interacting with the computer program	SPSS statistics or tabular display of results (SD, Mean etc) 20% reliability	Quantitative	Two research questions and 3 hypotheses tested (see chapter 5)
Experiment (pre- and post-tests)	To determine if the participant learnt new words using the computer programs	SPSS Statistics or tabular display of results (SD, Mean etc)	Quantitative descriptive data measures reading differences in the children (interval measure)	1 hypothesis: see chapter 4
Interview	To solicit the views of the teaching assistants and HCI professionals about the computer programs used	Nudist Pattern in the data	Qualitative	1 research question: see chapter 7
Attitude questionnaires	To determine the attitudes to the computer programs	SPSS Statistics or a tabular display of the results	Quantitative	4 hypotheses tested (see chapter 6)

The venue

The investigation was conducted at Wood Field School (a special school in the United Kingdom). The pre- and post-tests were conducted via four empirical studies in the ICT room of the school. The treatment/intervention was conducted in the same room. The attitude questionnaires sessions for the teaching assistants (TAs) was conducted in the ICT room and the interviews in the ICT office next-door. The next attitude questionnaire conducted was for Human Computer Interaction (HCI) professionals, and this was conducted on a university campus.

3.3.3 Writing the thesis: phase 3

The writing up of this investigation employed Kitchenham et al.'s (2002) research guidelines. The framework proposed guided the data collection, analysis, presentation of results, and interpretation of results and writing of the thesis. The writing of the thesis will be discussed further in chapters 8 and 9.

This research investigates how to design better interfaces for children with ASD, as the conventional approach to interface design for typically developing children will not suffice. What is needed is to develop a methodology to implement this investigation. Varied studies and theories were examined to determine their suitability for use in this inquiry.

Varied theories were examined in order to determine the one best suited to this investigation. The end-product is a combination of varied methods that will be 'suited for purpose'. The benefit of this is the combination of theories which offers this inquiry a wealth of methods.

Combining methods has its limitations, as it is problematic due to the difficulty of determining where and when each theory should be applied and, in cases where two or more theories overlap, which should be omitted.

An alternate method that could be employed is the mental model theory (in HCI), and the theories of communication in ASD were not included. Some of these omitted methodologies will be included in later chapters.

Problems during the Implementation and their Rectification

Some of the problems associated with researching ASD are the difficulty of recruiting participants for the investigation as well as the knowledge and experience of dealing with the sometimes volatile and explosive dispositions of the research participants.

Other constraints are the lack of resources for implementing the investigation.   Since this is a PhD research, funds for recruiting extra researchers to man the camcorder during the video recording sessions or manage the participants were unavailable for the implementation of the data collection during the pre- and-post tests as well as the video recording was limited.

This affected the data collection, for example in the video recording sessions, where the researcher had to operate one of the camcorders as well as give instructions to the participants about using the computer programs.

Other problems in the four empirical studies undertaken include:

- The sample of this investigation was small, owing to the nature of this inquiry and the characteristics and disposition of the main participants in this investigation (children with ASD). There are also the issues of limited access and difficulties in recruiting participants with ASD.

- There were accessibility problems and last-minute cancellations. There were a few occasions when the site had to be adapted at the last minute due to changes in location or the unavailability of the participants at the time. Nevertheless, the researcher was able to adapt quickly to such changes and achieved a free flow of test activities.

- In the first sets of interviews conducted in the schools, the venues, being on school premises, were sometime noisy and disruptive, as people kept walking by. As the venue incorporates a corridor, it was sometimes difficult to concentrate during the interviews, which created some difficulties during the transcriptions.

- The problem of testing children with ASD, who are non-verbal, and have limited communication skills, is challenging. This investigation had to devise a means for the participants to communicate the words known (in the pre-test) or words learnt (in the post-test) by employing Widgit communication software as well as a typed version of the words tested.

- One method used to test the words is the use of objects (as a substitute for or in combination with images) as well as typed words and symbols. The researcher soon realised that it is difficult to test the words with objects, as this could confuse the participants with ASD who may have generalisation problems. For example, using a toy bus or a model to test the word ’bus’ may be confusing for a child with ASD, who may not have translated the word ‘bus’ on the computer screen into the physical representation of a bus.

- Problems also arose during the video recording sessions, mainly due to the fact that the children were conscious of the researcher’s presence and this could affect their performance. Sometimes, the participants tried to block the video camera. As the researcher had to conduct the session and record the participants at the same time, the recording was sometimes obstructed or wobbly. There was also the problem of the time restraint. As the researcher had limited time in which to conduct the research, there was only one camera angle used during each video recording session and the sessions could not be redone. This may have led to a lot of vital information being lost, which, in turn, affects the reliability of the data.

- There were likewise problems with the interview data. As for the interview, as it was conducted on school premises, when the school was in session, its quality was reduced due to noise and disruption.

3.4 ETHICAL CONSIDERATIONS

The researcher gave ample consideration to ethical issues in the planning and implementation of this investigation (see appendix N). In planning this research, the researcher took into account the sensitivity of the research topic and the vulnerability of the research subjects. The researcher ensured that the participants’ rights and feelings were given paramount consideration, as stipulated in Greig and Taylor (1999).

The research design and procedures advocated were carefully deliberated upon, and it is anticipated that most of the ethical issues that surround this investigation have been explored. Close consultation was maintained in the course of this inquiry with the Ethics Committee in the Computer Science School in order to resolve the ethical issues related to the investigation.

Informed consent and confidentiality were upheld in this investigation (see appendix A). Proper consent procedures were followed and obtained from both the parents and the school. The confidentiality of the information obtained in this research was respected, and the personal information was kept private and used only within the context of the investigation.

Precautions were taken to ensure that the rights of the children/participants were not violated or compromised. The children were not coerced in any way. The tests was paused or cancelled altogether if the participant displayed any signs of unwillingness to take part in any of the activities. The issues related to the participants' wellbeing raised questions of how to conduct and manage the investigation without disturbing the routine and tranquillity of these children, since many of them had problems with changes to their routine.

Bias

To minimise bias and the misjudgement of the actions and disposition of the participants, some of the investigation was video-recorded. The researcher's experience of ASD provided a means of cross-checking the actions and dispositions of the participants. This was done with a great deal of caution in order to avoid contaminating the results with prejudice, misgivings, misinterpretations or misrepresentations.

The problem of how to apply subjectivity without bias in this research was neither easy nor clear-cut, as might have been anticipated; for example, in the interviews, the information obtained from the facilitators (classroom assistants and HCI professionals) of the subjects about the effectiveness of the computer programs employed in the investigation may have been completely free of bias. The implication of this process, in practice, is that, although the data collected was protected from being clouded with bias, this may not be the case. It must be stressed that the interviewees tried to answer the questions as honestly as possible. The interview results were reported in a fashion that reflected the participants' views and perspectives. Ample steps were taken to present the views and opinions of the interviewees in a fair, true manner.

Validity

The issue of validity is a pertinent aspect of any research, which needs to be given serious deliberation when considering the underpinning theory that a piece of research will advocate. In this investigation, close consideration was given to the epistemological perspective that best reflects the type of knowledge advocated in this inquiry (to validate the position adopted here). Questions, such as will the results expected from the research be validated by advocating the objective or subjective approach to knowledge, or by advocating both perspectives, were seriously considered.

There is also the question of whether the slight change or altering the seating arrangement to suit the needs of the children could have affected the results (for example in the pre- and post-tests). This is unlikely as the changes were applied only to the arrangement and not to the test content.

Attempts to promote validity in this investigation through extensive investigatory tasks were undertaken. For example, after the participants had completed the attitude questionnaires, they were interviewed in order to obtain a clearer understanding of the attitude questionnaire scores.

The use of facilitators was essential, due to the fact that the main participants in this inquiry were children with ASD and severe learning disabilities who were non-verbal. Teaching assistants were, therefore, used as facilitators. Their views and opinions were sought in order to facilitate communication and to give explanatory clarity to incidents, and the dispositions and actions of the children were noted whilst conducting this investigation.

Using facilitators created the ethical dilemma that the participants' views and opinions may be clouded by the facilitators' bias. Similarly, the facilitators may influence the test results, as they may use their pre-existing knowledge of the participants to determine the actions and dispositions of the participant, which may be wrong or misjudged. Nonetheless, the use of facilitators is essential to this inquiry as, without them, there would be little or no means of determining the children's actions and the interpretation of the factors that may influence the test results.

Generalisation

The essence of any research is to benefit people in society, so the issue of the generalisation of an investigation needs to be considered and applied where appropriate. Generalisation deals with the degree to which the findings of a research may be used beyond the specific situation in which they occur. It refers to the extent to which the findings of an inquiry are more generally applicable to other situations or times (Robson, 2002). The findings of this investigation can be applied to other children with ASD. However, generalising the findings of this inquiry has to be done with some discretion. Since ASD is a spectrum in which each person is affected differently by the disorder, not all of the aspects of the findings and recommendations of this investigation will apply to all children with ASD.

3.5 CHAPTER SUMMARY

This chapter discussed the methodology employed in this investigation. There was a lot to consider and a lot to examine, in order to achieve the best methodology possible to research this topic. This research converged theories from various domains, as it was found that no one theory will fulfil the expertise necessary to do justice to this subject area. The key theories that link all of the aspects employed include learning theories (investigating how children with ASD learn), HCI, and investigating the interaction between the child and the computer program and software engineering, which investigates the systematic design and development of the software. The chapter began by examining the underlying theoretical assumptions that should direct this inquiry; articulating the methodological issues that needed to be considered in order to optimise the methods and techniques employed in the planning and implementing of the investigation. The chapter ends by highlighting the problems associated with the methodology advocated and the methods employed, and ethical issues and other issues of bias and validity were also discussed.

Chapter 4

EMPIRICAL STUDY INVESTIGATION i: EXPERIMENTAL (PRE- AND POST-TESTING)

4.1 Introduction

Insufficient research has been done on improving Educational Computer Programs (ECP) to meet the learning needs of people with Autistic Spectrum Disorder (ASD) (Powell 2000). This chapter discusses the first step (pre-test) in determining if the programs in the public domain will improve the early literacy skills of children with ASD.

The appropriateness of ECP in advancing early reading skills (word acquisition) in children with ASD is investigated in this research, by conducting pre- and post-tests. These tests were deemed necessary in order to determine if the participants knew the words before being taught the words by the computer programs and after the words were learnt.

Appropriateness in the context of this investigation is determined by actual word gain, if new words were learnt and, to achieve this, tests were conducted to determine whether the words taught by the computer program were known prior to the children using the computer program and whether new words were learnt after exposure to the software.

Research Problem

The aim of this research is to investigate if children with ASD can learn new words using two computer programs. The subsequent aim, which is discussed in previous chapters, investigates how to improve the computer programs to accommodate the needs of children with ASD.

An efficient way of measuring the words known before and after the treatment of the children is to conduct a pre-test before the administration of a treatment (two computer programs were employed as the catalyst to learn new words and the measure is the number of words learnt (see figure 4.1)). Two computer programs only were selected due to the limited timeframe for this research as well as the limited number of participants.

Three programs were selected originally (based on the selection guidelines discussed in chapter 8) for this study, but, due to the fact that the third computer program (Wellington Square) was widely in use in the school, the choice of programs was reduced to two. The appropriateness of the two computer programs employed was determined by the number of words learnt by the participants. The experimental technique was thought to be best suited to this task. This investigation (as in a typical quasi-experiment) lacks the random allocation of participants to the treatment, and also lacks the full control of an experiment (Coolican, 2005).

Lacava et al. (2007) employed the pre-test – intervention – post-test in a investigation which investigated using assistive technology to teach emotions to 8 children with Asperger Syndrome (AS) and found that children with AS were able to learn about emotions using computer programs.

Distinct from the investigations discussed above, this investigation not only tests the benefits of ECP but also aims to improve them, in order to accommodate the needs of children with ASD.

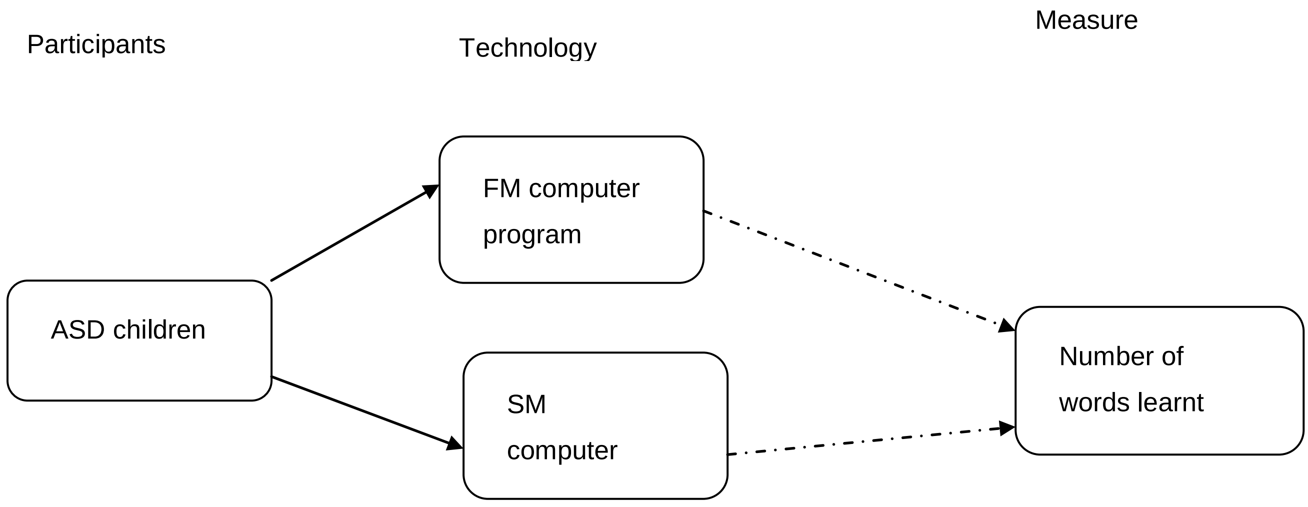
Hypothesis

The hypothesis tested is ‘Computer programs (‘Speaking for Myself’/‘Sentence Master’) will increase the number of words learnt in children with ASD’. The hypothesis above emanates from the research design which evaluates two computer programs from among the varied programs in the market in other to investigate the appropriateness of early literacy educational computer programs in helping children with ASD to learn to read (see chapter 1 for more details).

4.2 METHOD

The main task of this research is to determine if the participants in this investigation (5 children with ASD) had learnt new words after their exposure to the two computer programs. These two computer programs were chosen based on the fact that, given the characteristics and disposition of the participants, using a small number of programs was more viable, so, from the 20 computer programs identified, the choice was narrowed down to two. The two computer programs were considered on the basis of 3 criteria: criterion 1 (underling reading methods and objectives), criterion 2 (simple aesthetic and usability) and criterion 3 (appropriate for child with ASD; based on the researcher’s expert knowledge and literature on this subject, (see appendix C and chapter 1). Experiment-type tests (pre- and post-tests) were conducted in five children with ASD before (pre-test), and after (post-test) the treatment/intervention (as employed by Heimann et al. (1993, 1995) employed a similar method).

FIGURE 4. 1: THE EXPERIMENT TEST DESIGN FOR CHILDREN WITH ASD



The limitation of conducting a quasi-experimental type procedure is that, unlike a typical experiment, in which all of the conditions are fixed, there is, for example, the random selection of participants and allocation of treatment. In the current research, the random selection of participants for treatment was impossible due to the small number of participants with ASD who participated in this investigation. There was also a problem of the limited time for the participants to take part in this research, as they had other pressing activities, which did not allow them to devote more time to this investigation.

An alternate method of investigating this research is to employ the experimental method, whereby the independent variable (which, in this investigation, is the two computer programs) is manipulated by the application of treatment (which is randomly applied) to determine which of the computer programs produced the most words learnt (the dependent variable). However, due to the size of the sample as well as the nature and disposition of the children that took part in this investigation, this was not feasible. Children with ASD (who are the main participants in this research) have dispositional and behavioural problems which include a short attention span, hyperactivity and aggression if anxious, confusion and distress (especially if there are changes to their routine). There was difficulty recruiting children with ASD for the investigation due to there being limited schools and the school approach could not accommodate this research.

4.2.1 Participants

The participants in this investigation were aged 5, 6, 7, 7 and 10 years (5 children with ASD). The children were non-verbal and attended a special needs school, where most of the autistic students were part of an autistic unit. The age range of the children included in this investigation stems from the fact that, prior to the age of five, many children with autism, especially those at the severe end of the spectrum, are still trying to acquire the basic life skills (such as learning to communicate their needs, make eye contact, sit still and many others). It is between the ages of 5 and 10 that many children acquire the awareness, attention and interest (outside themselves) to be able to be taught to read (see the interview with the ASD educationalist in chapter

7). The children had a diagnosis of autism and severe learning disabilities. All of the children were non-readers (they could not read prior to the test) and all five children had severe autism.

Materials

The tools for learning the new words were two educational computer programs, 'Speaking for Myself 'and 'Sentence Master' .The pre- and post-tests were performed using the type the letter of the words test along with two to three other words. Symbols from Widigit (2000) software and Picture Exchange Communication System (PECS) were employed as a communication aid when conducting the tests (see figures 4.2 and 4.3), as all the children were non-verbal. For details on communication and ASD or PECS, see chapter 8.

FIGURE 4.2: SAMPLES OF SYMBOLS IN THE WIDIGIT SOFTWARE

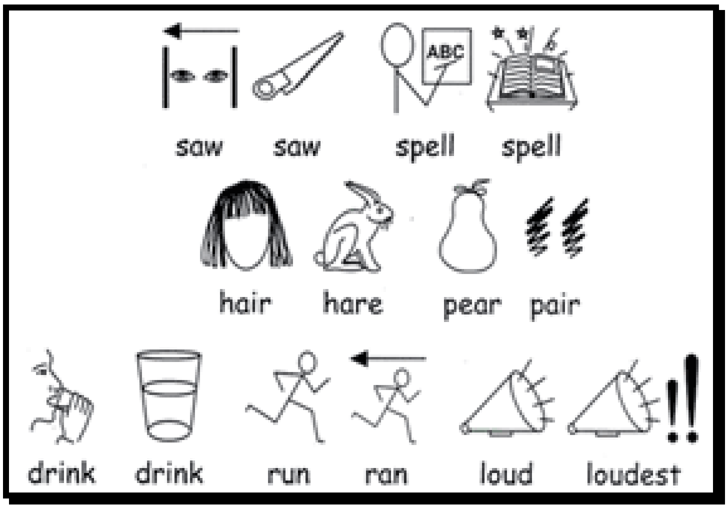
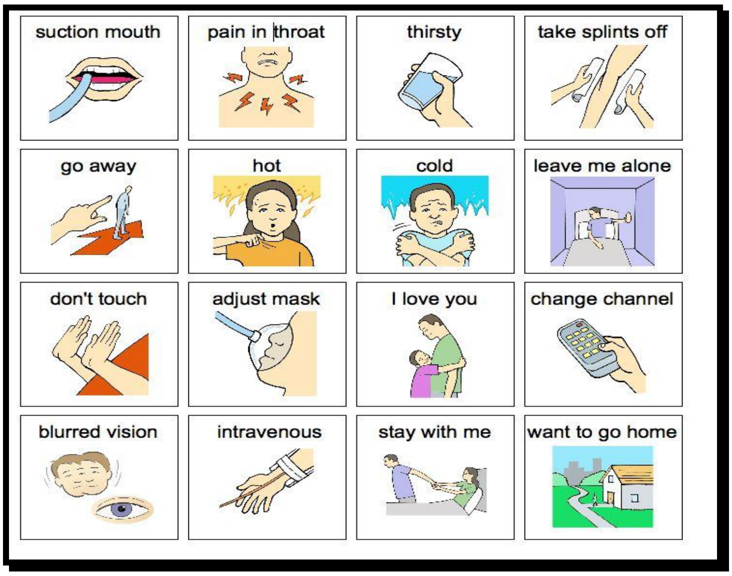


FIGURE 4.3: SAMPLES OF THE PECS FLASHCARDS



4.2.2 Procedure

Experimental-style tests were conducted, involving the children being tested for the words known before the treatment was administered, and after the treatment, (the post-tests) to assess the words learnt. The pre- and post-test sessions lasted 10-15 minutes each (to accommodate the children's short attention span). Two to three words were tested in each session. Lots of verbal promoting (in the form of encouraging words like 'good try' or 'try again') was used to help to sustain the child's attention (as suggested by Jordan and Powell, 1990) and to keep them motivated, as supported Moore and Calvert (2000). Moore and Calvert, in a study, comparing the attention, motivation and learning of words in a behavioural programme and an educational program, employed rewards and verbal praise or playing with a desired object as a reward when the children got the right response three times in a row. The current investigation differs from that study in the sense that it recognises that, due to the severity of the ASD condition, a more immediate reward was necessary to keep the children motivated and to sustain their attention.

As all of the children in this part of the investigation were non-verbal, symbols and PEC (as discussed above) were employed as the communication tools during the tests. The tests were designed and implemented in a linear fashion, where each word was tested twice in order to verify that it was understood by the subject before another word was tested.

The choice of the words taught/tested was based on two considerations; 'visual' or 'concrete' words (i.e. words such as 'bus' or 'biscuit') and familiar or everyday words (words the children are familiar with such as 'drink' or 'sleep'). These words were chosen from the list of word in the computer programs. The teaching assistants (TA) gave advice on the appropriateness of the words to include or exclude from the experiment. The words taught/tested are 'biscuit', 'sleeping' and 'drink' (in the FM software) and 'bus' 'robot' and 'the' (in the SM software).

Pilot study

A pilot run of the tests was conducted with one participant. The pilot test served as a dummy-run, in which the researcher could try out and adapt the test to accommodate the needs of the child. As the research participants were children at the severe end of the autistic spectrum, careful consideration of their disposition (for episodes of behavioural problems or hyperactivity) was needed in order to achieve an effective and fruitful test. Therefore, a number of trials were needed to try to pre-empt as far as possible the likely problems that may arise in the course of the tests. For example, the sitting positions in which the children will be more receptive to be tested and the type of communication tools that the children will prefer (for further on the communication tools, see the discussion section below, as well as chapter 8).

The pilot test session was video-recorded using two camcorders which were mounted to record the activities of the subjects on the computer and also the subject's disposition whilst interacting with the computer programs employed in this investigation. It gave the opportunity to record the participants in a most unobtrusive and inconspicuous way, without distracting them from their activities (figure 4.4 provides a sample of the recording).

In summary, the pilot study facilitated the refining of the processing, as well as the implementation of this part of the investigation; the plans with regard to the content of the test, the venue, managing the limited time for the investigation and the children' dispositions. Another benefit to this investigation is that this pilot allowed the observation of different plans under varied circumstances from many different angles and to try out different approaches on a trial basis before undertaking the main study, as noted by Robson (2000), who advocates pilot studies as a pertinent tool in any investigation.

FIGURE 4.4: PLAN VIEW OF THE VIDEO RECORDING VIA TWO CAMCORDERS

Pilot sample of the a child using the program to learn to read words

The Computer Programs

Synopsis of the computer program 'Speaking for Myself'

'Speaking for Myself' (FM) is an educational program manufactured by Topologika. It is a multimedia-based program aimed at promoting early language, communication, reading and ICT skills. The target audience of this program are children aged 2-9 with special educational needs. The program combines the use of audio, video and animation (see figure 6. 1 below). The computer platform is a Personal Computer (PC) or Apple MAC Computer (Mac). The areas of the curriculum it addresses are reading and communication. The skills required of the user when using this computer program are familiarity with touching the screen or mouse clicking skills (see chapter 1 for more details about this program).

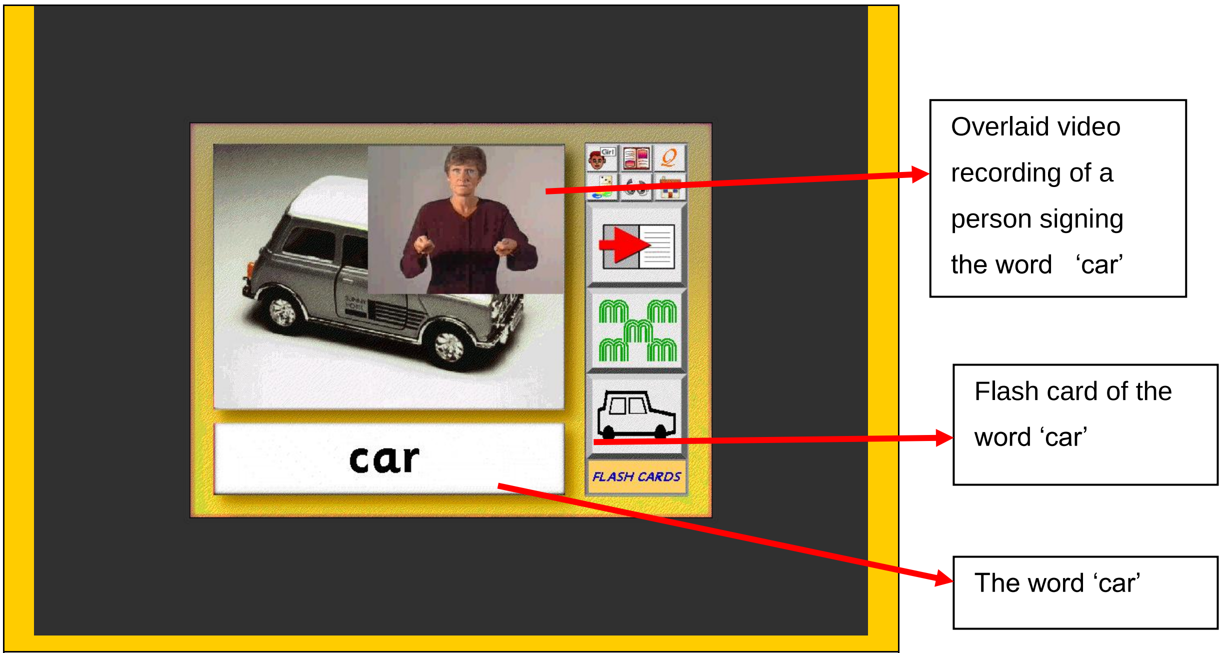


FIGURE 4. 5: EXAMPLE OF THE "SPEAKING FOR MYSELF" INTERFACE

Synopsis of the computer program Sentence Master

The Sentence Master (SM) program was written by Blank (1996) and manufactured by Laureate. It is a linguistic-based reading program that combines multimedia technology (see figure 4.6 below) and printing resources. It is targeted at pupils who suffer from problems with developing and mastering reading. The content of the program is 150 words in total, divided into several levels. The reading method advocated by the Sentence Master Program is based on the learning strategy of 'Over Learning'. Over learning, according to Rohrer et al. (2005), is a repeated learning strategy which extends beyond the criterion of one perfect instance. In the SM program, words were repeated 40 to 50 times each i.e. the word (see chapter 1 for more details about this program).

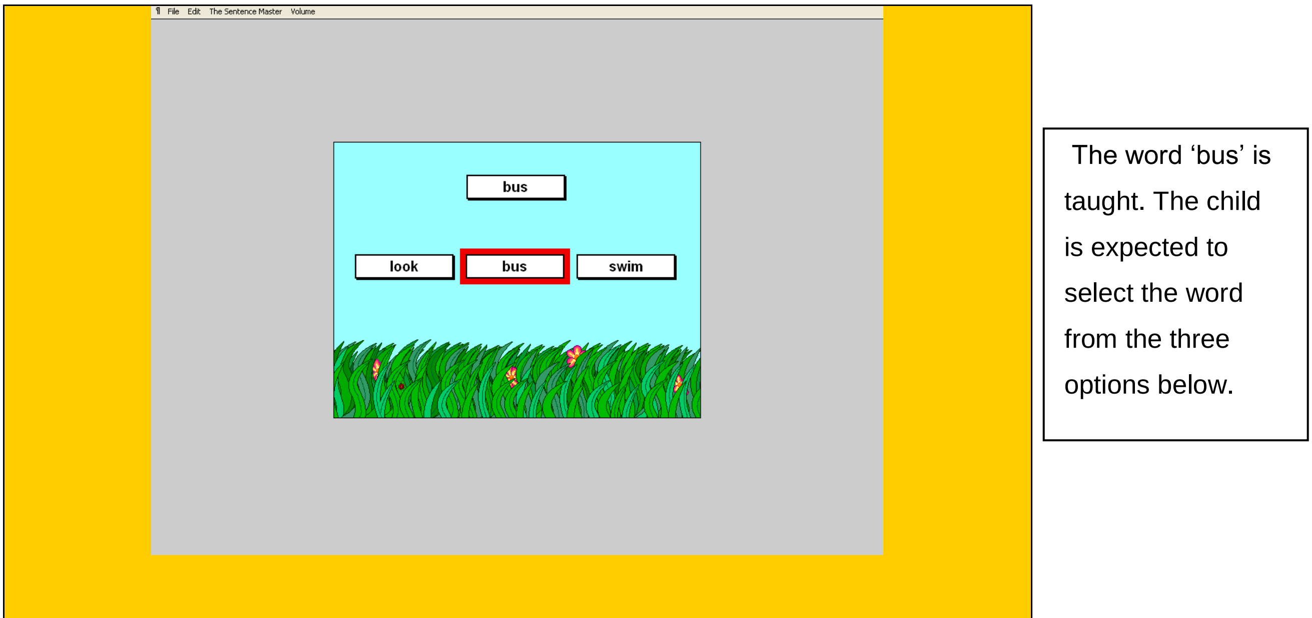


FIGURE 4.6: EXAMPLE OF THE "SENTENCE MASTER" INTERFACE

The words taught were randomly selected from each computer program with no specific linguistic organisational consideration; examples of these words are 'bus' (from the SM program; see figure 4.6) and 'drink' (from the FM program). Each word was tested twice in order to affirm the child's response.

4.3 RESULTS

The results recorded in the pre- and post-tests above (tables 4.1 and 4.2) indicate some gains in teaching new words to children with autism and severe learning disabilities using the computer program "Sentence Master" (SM), but limited gains from using "Speaking for Myself" (FM).

TABLE 4.1: PRE- AND POST-TEST RESULTS SOFTWARE FM						**TABLE 4.2: PRE- AND POST-TEST RESULTS SOFTWARE SM**					
Participants ID	**Pre- intervention score**		**Post-intervention score**		**Gains**	**Participants ID**	**Pre-intervention score**		**Post-intervention score**		**Gains**
	Words tested	Words known	Words tested	Words known			Words tested	Words known	Words tested	Words know	
ASD1	3	0	3	0	0	ASD1	2	0	2	2	2
ASD2	3	0	3	0	0	ASD2	3	0	3	2	2
ASD 3	3	0	3	2	2	ASD 3	2	0	2	2	2
ASD4	(AT)	(AT)	3	2	-	ASD4	(AT)	(AT)	(AT)	(AT)	(AT)
ASD 5	3	0	(AT)	(AT)	0	ASD 5	3	0	0	0	0

<u>Comments</u>: ASD 4 in the FM program had no pre-test scores. ASD 5 in the same program had no post-test scores. Absent is depicted by <u>AT</u>.

A summary of the results from the FM program indicate gains by only ASD 3, with a record of two new words learnt in the post-test. ASD 1 (or child 1 in the ASD children) recorded no correct answers for the three words tested in the pre- and post-tests. ASD 2 recorded no word known in the pre-tests and no word gain in the post-test. ASD 3 recorded no word known in the pre-tests and two words gained in the post-tests. ASD 4 was absent from the pre-test, while ASD 5 recorded no right answers in the pre-test and was absent from the post-test.

The scores for the post-tests indicate that the SM program promoted the learning of new words in 3 of the 5 children but only one in the FM program, suggesting that the SM program is more suited to teaching new words in the children tested. A conclusive judgement, however, on the most suitable computer program will follow in subsequent chapters. Discussion of the results and an analysis as well as judgement of both programs will follow in chapter 8.

4.4 Chapter Summary

This chapter is discussed in four sections, the first part introduces the experimental test technique, and discusses why this method is deemed necessary, as well as explaining the problems that this techniques aims to address. The literature on similar investigations is discussed as well as the processes and procedures of the test results, and a discussion of the results then follows.

The pre- and post-test procedures and results were employed as a tool to determine if exposure to two computer programs will result in word gain for 5 children with ASD. It launches the investigation into the standardization of computer programs for children with ASD. The subsequent chapters provide more detailed research and additional content for the standards. The results of the tests were listed and discussed along with the implications of the results and the need for further investigation into the phenomena.

Chapter 5

EMPIRICAL STUDY INVESTIGATION ii: USER INTERACTION

5.1 Introduction

This chapter discusses the investigation of standardising educational computer programs ('Speaking for Myself' (FM) and Sentence Master' (SM)) in children with Autistic Spectrum Disorder (ASD) and Typically Developing children (TD).

The chapter is divided into four sections. The first part introduces the observation method, discussing why this method is deemed necessary, as well as listing the problems that the observation approach aims to elucidate (in the light of the research problems), and noting the literature on similar research. The processes and procedures of the results and a discussion of the results then follow. It is anticipated that the video recording and analysis of the interaction will provide insights into ways of improving the current design and development of Educational Computer Programs (ECP) for children with ASD.

In conducting an observation of children with ASD, it is essential to understand the learning and developmental challenges and problems related to involving children in a study of this nature, as these factors will impact on the process and procedures of the study, as well as the results.

5.1.1 Background

Video recording is a place method used to research children's behaviour (as discussed below). Video recording was employed as a tool to observe, first-hand, children with ASD using ECP when interacting with the computer. The observational technique is a systematic method of quantifying pre-defined actions or behaviour, as stated by Bakeman and Gottman (1987).

Several researchers have employed the video recording (observation) method to investigate ways of supporting children with ASD when using computer technology. Chen and Bernard-Opitz (1993), in a study which compared Personal Instruction (PI) with Computer Assisted Instruction (CAI), utilised the videotaping of 4 children with ASD; measuring motivation, behaviour and learning rate using these two methods. Heimann et al. (1995) employed video recording (as well as pre- and post-test quasi-experiments) in a study which investigated the effect of using an interactive and child-initiated microcomputer program (Alpha), when teaching reading and communication skills to three groups of children, 11 with ASD, 10 pre-school children and 9 children with mixed disabilities. Tjus, Heimann and Nelson (2001) employed the videotaping (observation) approach in a study which investigated literacy skills in 20 children with ASD and mixed intellectual disabilities.

Williams et al. (2002) evaluated the progress of 8 ASD children aged 3-5, in developing reading skills in two conditions; computer-assisted learning and book-based learning. This Middlesex University Research for children with Autistic Spectrum Disorder (MURASD) employed video recording which was programmed to enable the recording of 35 predetermined behaviours. Robins et al. (2005) employed the observation method in a study that used robots in the therapy and education of 4 children with ASD. Hertzroni and Tannous (2004) employed video recordings of 5 children with ASD in a study which investigated the use of a computer-based intervention for enhancing communication.

Although several studies (as noted above) on ASD children have researched this subject, however, these investigations are limited in several respects. Firstly, the previous researches focus on children with mild to moderate ASD; this may be due to the difficulties associated with working with children at the more severe end of the spectrum of this disorder; for example, some characteristics of more severe ASD are serious behavioural problems, which may involve self-harming or harming others, attention problems, hyperactivity and communication problems, as well as logistical problems, such as problems with obtaining access, planning and resources (see chapters 4 and 8). According to the National Autistic Society (2008a), about 50% of the population of children with ASD have SLD, buttressing the importance of this MURASD research.

Secondly, some research omits the use of the observation (video recording sessions) method, which provide a wide range of benefits, including providing first-hand information on the interaction between the child and the computer, presenting important information on the child’s actions and disposition whilst using the program, and thereby providing the child’s likes and dislikes and phenomena that can be viewed during the observation process. Instead, these researchers employ complementary methodologies, such as questionnaires, interviews and experiments, which, although they have some merit, are useful in addition to other data gathering methods.

Investigating this topic will advance knowledge in researching children with more severe ASD by, for example, providing some insights into how to manage children with this disability during research, as well as showing that it is possible to research children with ASD successfully in an education-based investigation, with a view to advancing supporting learning to read using computer programs.

The main research question (A):

'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'

Motivated research questions (B):

R1: Can an educational multimedia computer program sustain the attention of children with Autistic Spectrum Disorder (ASD)?

R2: Can an educational multimedia computer program motivate children with Autistic Spectrum Disorder (ASD)?

R3: Can an educational multimedia computer program engage children with Autistic Spectrum Disorder (ASD)?

From these questions, the following hypotheses can be developed, based on the three measures of attention, engagement and motivation as compared across two types of computer program ('Speaking for Myself' and 'Sentence Master'), both intended to facilitate early reading in children with ASD.

(H1)The looking (sustained attention) time will be greater in children with ASD when we employ a computer program that contains animation, with respect to the child looking for extended periods of time at the computer screen.

(H2) External prompts (computer, physical and verbal prompts combined) are needed to keep children with ASD responsive (motivated) when using computer programs. In essence, the greater the number of prompts, the more the child touches the computer screen.

(H3) Episodes of boredom, stress or lack of engagement will be greater in children with ASD when using a computer program that contains high levels of repetition due to the child becoming bored or frustrated as a result of the cognitive problems in ASD, such as hyperactivity, limited attention span, ritualistic, repetitive, and stereotypical and compulsive behaviour, as reported by Siegel (2003) and Damasio et al. (1978).

Therefore the programs are evaluated for effectiveness in three areas, with comparisons between ASD and TD children.

(a) Sustaining attention in children.
(b) Motivating the children.
(c) Engaging the children.

The video recording of the children interacting with the computer programs offers an efficient way of measuring the effectiveness of the computer programs (in the above listed areas).

5.2 Method

The observation method included using video recordings of children interacting with the two computer programs. This tool was employed to measure the predetermined actions of two groups of users; children with ASD and TD children. The session recorded for each group of children was implemented as part of their intervention. Each session was videotaped, using two camcorders. Camcorder A was mounted on an elevated surface, focused on the child and recorded the subjects' attention, expressive vocals (utterances, for example, loud noises), and behaviour. Camcorder B was operated by the researcher and recorded the child's actions on the screen. The analysis of both recordings will give some indication of the child's user experience in both conditions. The second group of children were video recorded, employing the same method as a means of comparing the reactions of both groups to the same learning experience.

5.2.1 Participants

10 children were recruited for the video recording sessions. The first group consisted of 5 children aged 5-10 who had been diagnosed with ASD and severe learning disabilities. They were recruited from a special school and were part of an autistic unit. Informed consent was sought from the school and the parents or guardians of all of the participants. The age range of the children from the ASD group included in this study stems from the fact that, prior to the age of five, many children with ASD, especially those at the severe end of the spectrum, are primarily still trying to acquire basic life skills (such as learning to communicate their needs, make eye contact, sit still and many other day-to-day skills). It is between the ages of 5 and 10 that many children have the awareness, attention and interest (outside themselves) to be able to be taught to read.

TABLE 5.1 PROFILES OF THE PARTICIPANTS WITH ASD

CHILD ID	AGE	READING LEVELS	COMMUNICATION TOOLS THE CHILD EMPLOY
ASD1	9	Non-reader	PECS1 and Symbol
ASD2	7	Non-reader	Photographs
ASD3	7	Non-reader	Photographs
ASD4	6	Non-reader	Used a personalised PECS collection
ASD5	5	Non-reader	Photographs

All of the children were non-readers (they could not read prior to the test; see table 5.1). There were two identical tests performed, before (the pre-test) and after (the post-test), with an intervention process in between. The pre-test involved each participant being tested with words extracted from the educational

[1] The Picture Exchange Communication System (PECS) is an alternative, augmentative communication system that teaches children to initiate spontaneous communication.

computer program. Symbols from the Widigit 2000 program were used as a communication aid in the conducting of the tests (this will be discussed in greater detail later).

As Mental Age (MA) measures were unavailable for the ASD group, it was impossible to match them exactly to the TD children. The children in the latter group were chosen from 4-6 years of age, as they would be mostly pre-readers and have cognitive abilities that are more similar to 5-10 year olds with ASD than chronological-age matches.

The second group of children (the TD group) consisted of 5 children aged from 4 to 6 years old. They were recruited for this investigation from a homework club, with consent obtained from their parents or guardians. The age range of these children was determined to try to match the intellectual and developmental ages of the children in group 1. The two groups selected were also matched as closely as possible in order to establish the similarities and differences between both groups for the three measures observed.

The TD children are at the pre-reader stage, from age 3½ (and in some cases earlier) to 5 years, in contrast to the children with ASD (at the severe end of the autistic spectrum), who are at the pre-reader stage from ages 6-12 or even later (some may never progress beyond the pre-reader stage).

Another noticeable difference is that children with ASD may need one to one supervision by a classroom assistant when they are using the computer technology; this may not be required by the TD users.

5.2.2 Procedure

The video reading session (treatment or intervention) was performed with the two groups of children, children with ASD and TD children. This investigation employed two computer reading programs (the independent variable) for children with ASD: FM (‘Speaking for Myself’) and SM (‘Sentence Master’). The children were video-taped using both programs for 5-15 minute sessions. The length of the session was constant for the TD children but varied for the children with ASD due to individual differences between the children and their restlessness.

The video recordings were edited from two cameras that were synchronised (see figure 5.3) into two screens on a frame. The first screen displays the computer interface, whilst the second shows the child using the computer program. One of the screens (screen 2) had a timer superimposed to allow the precise coding of the events (the first set at 00 for the hour, the second at 00 for the minutes, the third for the seconds and the last for the number of frames; there are 25 frames per second). The multimedia video editing software, Final Cut Pro, was employed to edit and synchronize the recordings. The viewing and coding of the recording was done using a Panasonic NV HS960 super drive multi-intelligent control IIVHS player, a JVC 14-inch television and an editing controller ww-EC500E.

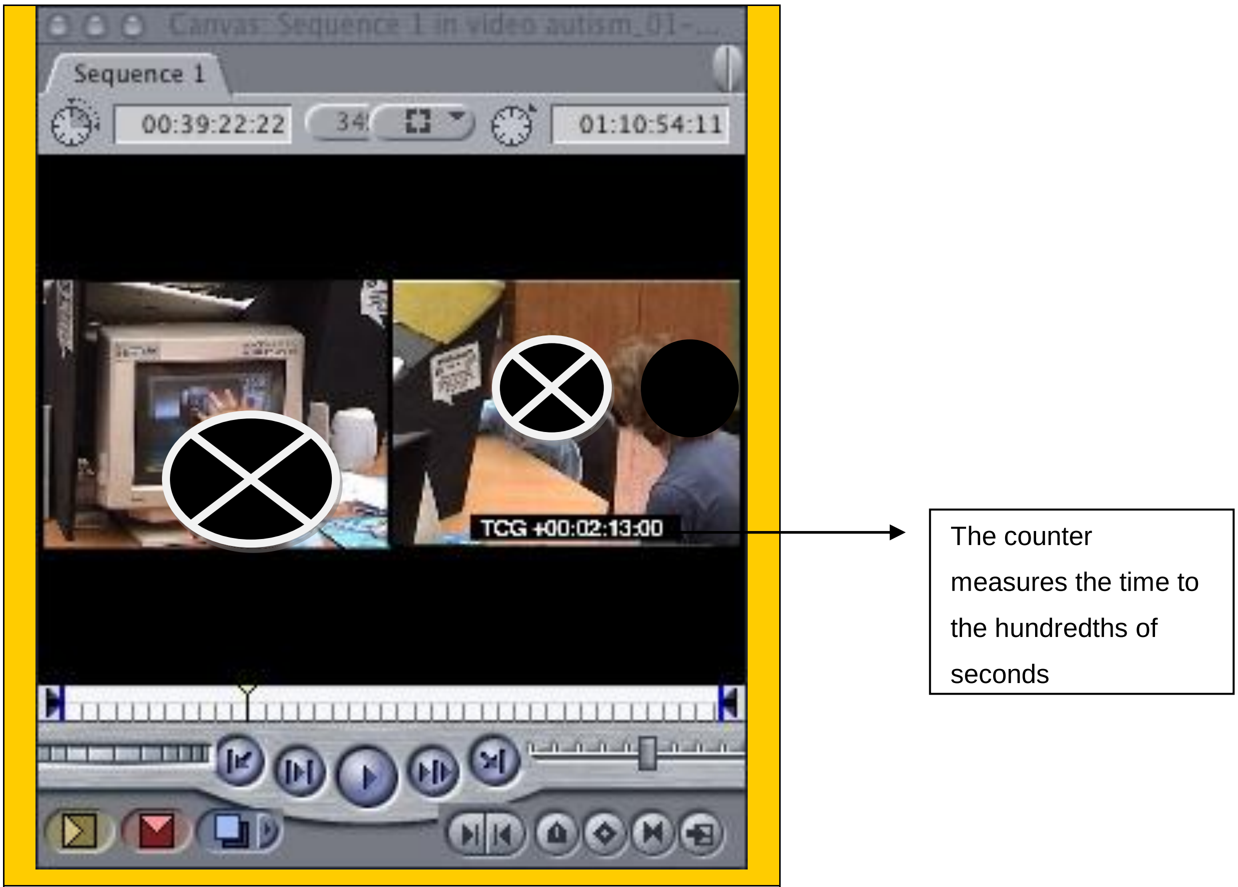


FIGURE 5.3: SAMPLE OF THE VIDEO RECORDING

Conducting video recording sessions of children with ASD, who have severe learning disabilities, which lead to behavioural problems, is a difficult venture. Little research has been done in this domain due to the difficulties and complexities involved in working with these children and the challenge of conducting such a study. It requires serious thought and planning. The characteristics, disposition and temperament of the children play a key role in the selection of the techniques employed in this study. The children with ASD were conscious of the researcher's presence and this could have affected their behaviour, as some children tried to reach for the video camera or leave their seat and wander around the room.

The researcher had to cope with problems of amendments and changes of time slot to accommodate the temperaments and dispositions of the children with ASD. Dealing with last-minute amendments to the schedule allocated for this study made implementing the study difficult on occasion. There were accessibility problems and last-minute cancellations, to accommodate the times allocated by the school for this study. There were a few occasions where the site had to be adapted at the last minute due to changes in location or the unavailability of the children with ASD at the time originally scheduled for the study. Nevertheless, the researcher was able to adapt quickly to such changes and achieved a free flow of test activities.

5.2.3 The Coding Scheme

There were separate measures for each type of action or behaviour, which provide the means to measure:

Visual Attention (research question B, A, H1)

Motivation (responsiveness), (research question B, H2)

Stress and boredom (engagement), (research question B, C, H3)

The coding requires the use of the jog shuttle control[2] to determine the onset of the observed events. The onset in this investigation is defined as the time recorded on the counter to the hundredths of a second (see above).

The coding scheme included:
Visual Attention
Measured by the amount of looking action (see below), by measuring the length of time spent looking at the computer screen (how long the computer program holds the child's visual attention).
Visual Attention Coding Scheme; form 1 (see observer user guide appendix L and below).
The coders view the video recording and note the length of time (duration) for which the participant looks at the computer screen (either with or without the participant touching the computer screen). The looking event begins (the onset) when the participant looks at the computer screen for more than 2 seconds (continuously) and ends (offset) when the participant looks away for more than 2 seconds. Two seconds was employed to give sufficient time for the behaviour or action to be recorded.

Motivation
Motivation is measured in terms of the child touching the interface in response to a prompt or command by the interface or a prompt by a facilitator[3] and the computer program prompts. The response is measured in terms of the frequency of touching the computer screen by the children in response to prompt vs. spontaneously touching the interface.

Touching actions are subdivided into three parts, three of which are the functions of the different types of prompt:

- Touching the computer screen in response to a physical prompt (involves the assistants taking the participant's hand and placing it on the computer screen).
- Touching the computer screen in response to a verbal prompt by the classroom assistant; for example, words of encouragement or positive feedback (such as 'try again', 'again', etc).
- The touching of the computer screen in response to the computer program prompts (involves the computer verbally encouraging the child to touch the computer screen or a change in the interface; such as the page changing to the next page).

The last measure in the touching condition is spontaneous touching, which is measured by the touching of the computer screen without any prompting.

[2] The jog shuttle control is an electronic device used to control the video recording; it is especially useful for viewing a video recording frame by frame.

[3] The classroom assistant or IT coordinator acted as the facilitators.

The motivation coding scheme (see above)

In form 2 (see appendix L and below), the children's actions (touching the computer screen) are defined as being accompanied by neutral, positive, or negative affects, besides the different types of prompt. A neutral affect is when a child displays no expression, a positive affect is when a child displays positive expressions (such as smiling) and a negative affect is defined when a child vocalises a complaint or performs actions such as hitting the computer screen, self harm, etc.

Stress and Boredom (engagement)

Stress and Boredom (engagement) measures the duration of any stress and boredom in the session coded.

Stress and Boredom (engagement) coding scheme (as above)

Form 3 (see appendix L and below) reports the duration for which the children display behaviour such as vocalisation, hand flapping, negative affects or hitting his/her head, as measures of stress or boredom, (all typical for ASD children, as attested by Frith (1989)) and hence disengagement from the learning experience.

Further details about the coding strategy

Every time there was an action, this was coded. There were two types of measure in the coding scheme for momentary events, frequency (touching the screen), and duration events (measuring the length of time between the onset and offset of an action e.g. looking at the screen). If two or more actions occur [for example: 1 attention, 2 motivation, 3 engagement], they are all coded. In other words, the coding scheme categories applied are mutually exclusive; which suggests that they are coded in only one of the three forms employed (see appendix L). The frequency of touching and looking at the screen (behaviour) may occur simultaneously. (For the forms used for the coding, see appendix L, and appendix P for a sample of a completed coding form).

The Observation Coding Guide

The observation coding guide is designed to facilitate the coding of the video recording. The document is divided into two sections (the general coding procedure and the coding procedure specific to the measure being coded). The document provides a guide to the coding process, giving details about how each aspect of the coding schemes should be applied. The guide begins with a general coding procedure, which applies to all three behaviours: measured visual attention, motivation and boredom and stress (engagement). All behaviours are mutually exclusive within each form. To ensure the reliability of the coding, a secondary coding was conducted by a second coder (see the reliability section below).

The general coding procedure

- The timing for the action commenced within two seconds from the start of an action, such as touching the computer screen; this was done to give adequate time for an action to commence before it is recorded, as well as to ensure the accuracy of all actions measured. This is classified as the 'onset' or start of any action and 2 seconds 'look away' time is classified as the end of the action.
- The coding of the recording should be done frame by frame for the 'look 'action to ensure that both observers are viewing the same action.

- To minimise the problem of discrepancies caused by obstruction and visibility problems, the screen with the timer is the main screen used but, in the case of obstruction (limited vision); the second screen is used, although the time shown on the main screen was always the one used.
- Record at the bottom of each form the screen employed to code the recording.
- Turning the screen on and off (even when the child is looking at it) should not be counted as an action.
- The coding of each form should be made using normal play, slow play or as necessary, to facilitate accurate timing.

Screen 1 is the screen without the timer, whilst screen 2 has the timer displayed beneath it.

Coding steps for visual engagement (form 1):

ii. Play the tape, pausing where looking occurs.

ii. Record the duration of looking.

iii. Onset begins after 2 seconds and offset after 2 seconds.

Coding steps for motivation (form 2):

ii. Play the tape, pausing where touching occurs.

ii. Record the exact time of the touching.

iii. A positive affect is when the child smiles.

Procedural guidelines

An action (touching) accompanied by a positive affect should be coded. A positive affect is when the child is smiling or not showing signs of displeasure (such as crying).

Explaining the various prompts

A physical prompt can be the child guiding the hand of the assistant to the computer screen (this will include the assistant touching the computer screen without talking to the child). Verbal prompts are words of encouragement. A computer prompt is the computer verbally prompting the child or a change in the interface (such as the page changing to the next page). A spontaneous prompt is any other prompt that is present.

Coding steps for boredom and stress (form 3):

ii. Play the tape, pausing where incidents of negative behaviour occur.

ii. Record the exact time of the behaviour observed.

iii. Onset begins after 2 seconds and offset after 2 seconds.

Actions explained

Flapping of hands, covering of the ears with the hand(s) and other repetitive hand movements

Continuous vocalisation (making small or loud sounds or crying)

Negative affects (include actions, such as self harm, continuous hitting of the head with the hand, covering the ears with the hands, and facial expression, such as frowning, turning the computer monitor on or off and chewing on objects or clothing).

Reliability

The reliability of the coding system is crucial to the success of the observation method, due to the fact that it provides an avenue for determining the accuracy of the phenomena being observed and the replication of the coding process, as proposed by Bakeman and Gottman (1987). To ensure that the phenomenon coded is objective and repeatable, the Kappa agreement technique was employed (ibid). This technique was applied, comparing the coding of the two observers of 20% of the data (as is the convention). The average inter-observer agreement was computed at 93% (see appendix G) for verifying the coding observation videos. This indicated a reliable, high level of consistency between the two coders. Lessons were learnt from embarking on this venture, especially in the modification of the observed coding scheme (discussed above).

5.2.4 Data reduction

The data collected were divided into two categories. The first aspect measured predefined behaviour (attention, motivation and engagement) individually and then in groups (ASD vs. TD). In the second part, chi square test (chi- square or X^2 test)[4] was employed to compare the distribution of the results (in attention, motivation and engagement category), the alpha levels of the X^2 test was set at p=.05.

For the data reduction, stage 1 calculated the defined behaviour (frequency and duration) individually; in the data relating to visual attention behaviour, the dependent variable (DV) (duration of visual attention) was analysed in terms of the number of children who displayed this behaviour.

In terms of motivation, the DV (touching the computer screen in response to prompts, accompanied by neutral, positive, or negative affects) was measured in terms of the frequency of the behaviour (see details above). In the data relating to engagement, the DV (engagement) was analysed to measure the duration of the time for which the children show engagement or lack of engagement behaviour.

The data were analysed (attention, motivation and engagement) using chi square tests. Due to the small sample size, the data were analysed as single cases for the ASD children when comparing the two programs. In stage 2, data comparing the ASD with the TD children were analysed in terms of the number of participants from each group who did or did not produce the target behaviour.

[4] The ^{X2} test is a statistical hypothesis test which measures the distribution of the results, by enlarging the sample size in order determine the distribution of the results.

5.3 Results

This section of the thesis is discussed in three parts corresponding to the three types of behaviour measured (attention, motivation and engagement). For each of the three measures, the results are reported for the ASD then the TD children. A comparison between the two types of software will only be possible in the cases where the child completed both computer software tests (FM & SM). The results are finally discussed in the subsequent section.

5.3.1 Visual Attention (Looking Behaviour)

The data were first analysed in the form of looking time, and proportional looking time was used to calculate the percentage of time for which a child was looking at the screen compared with the total duration of his/her session. These results are presented in sections 5.3.1(A) and 5.3.1(B) for the ASD and TD children respectively.

5.3.1(A): Looking Time for Software (ASD Group)

Percentage of Time Spent Looking At the Screen (%)

The percentage of time for which each child looked at the computer screen in both computer programs is depicted in figures 5. 4 and 5.5. In the FM software two children scored above 50% and one child scored below 30%, in the SM, three children scored above 50% and one child score below 30%. For children 1 and 2, the results indicate that child 1 had more occasions of looking at SM software (81%) than for the FM software (29%), while the difference between the two software programs was marginal for child 2 (SM=64%, FM=71%).

FIGURE 5.4: LOOKING TIME IN PERCENTAGES FOR SOFTWARE FM (ASD)

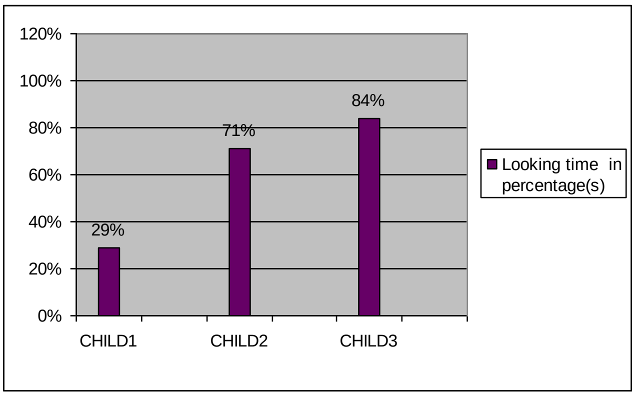
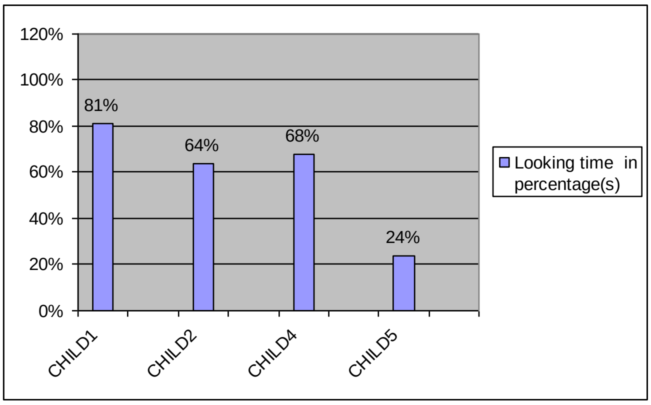


FIGURE 5.5: LOOKING TIME IN PERCENTAGES FOR SOFTWARE SM (ASD)



CH4 and CH5 were absent from session FM, and CH3 from the SM session

5.3.1(B): Looking Time for the Software (the TD Group)

Similar comparisons were carried out with individual TD children. The duration of looking time for the FM is greater than for the SM. The results concerning looking times in the TD children are similar to those of the ASD children (for further details, see tables 5.4 and 5.5). The general results showed high levels of looking for both software programs.

TABLE 5.4 : LOOKING TIME FOR SOFTWARE FM (TD)			TABLE 5.5 : LOOKING TIME FOR SOFTWARE SM (TD)		
Child	***Session duration***	***Results in seconds of looking duration***	***Child***	***Session duration***	***Results in seconds of looking duration***
TD1	128	83	TD1	176	174
TD2	86	82	TD2	81	19
TD3	216	216	TD3	301	298
TD4	231	231	TD4	295	295
TD5	343	224	TD5	194	156

Proportion of Time Spent Looking At the Screen (%)

Figures 5.6 and 5.7 shows the results of looking in percentages and give a clearer indication of the level of looking in both situations. They show that child 2 preferred the FM, while children 1 and 5 preferred the SM software, and children 3 and 4 had no preference.

FIGURE 5.6: LOOKING TIME IN PERCENTAGES SOFTWARE FM (TD)

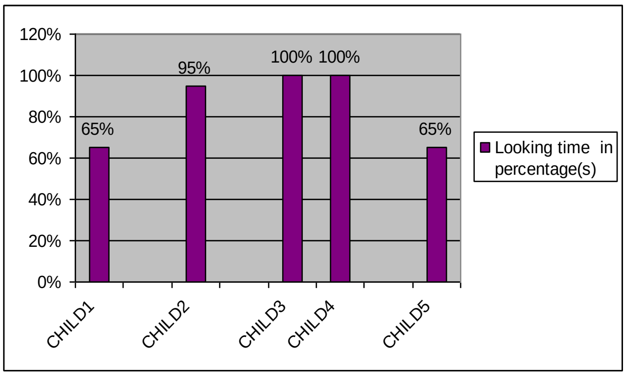
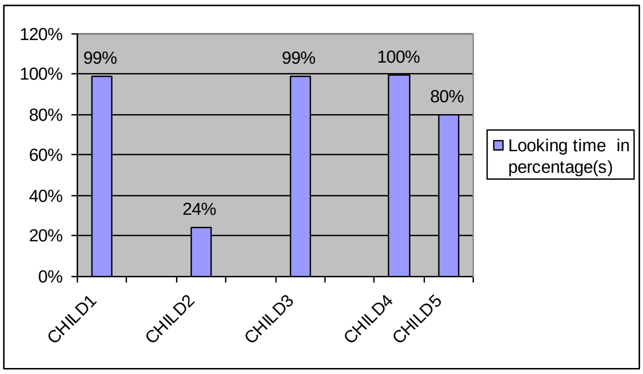


FIGURE 5.7: LOOKING TIME IN PERCENTAGES SOFTWARE SM (TD)



Comparing the ASD and TD children using percentage scores indicates a higher looking time for the TD children. However, both groups showed a good level of interest, as demonstrated by the percentage of looking time at the screen for both the FM and SM software.

5.3.2 Motivation

Motivation is quantified as the measurement of the response to three behaviours (physical prompt, verbal prompt, computer) and spontaneous touch. The child's touching of the computer screen is recorded in response to the afore-listed behaviour. The frequency of the touching behaviour in response to prompts, followed by X^2 tests, as presented in sections 5.3.2(A) and 5.3.2(B). The X^2 test is recorded for the ASD and TD children correspondingly.

5.3.2(A) Frequency of Touch Behaviour following Different Types of Prompt (ASD)

The results shown in figures 5.8 and 5.9 illustrate that there was a greater amount of touching behaviour (in response to the child being prompted) for the FM than the SM software. A comparison of the two participants (children ASD1 and ASD2) show that child 1 had more touching in the SM than the FM software, whilst child ASD2 recorded more touching in response to the prompts in both software conditions. The highest amount of touching was recorded in child ASD3 (for further details see tables 5.6 and 5.7 in appendix O).

An interesting comparison than can be drawn between the different prompts. Two distinct groups can be created from the prompts measured in this investigation. The first is the external moderated prompts (whereby the child is either physical or verbal prompted) and system prompting (the computer verbally prompting the child) and self moderated prompts (the child touching the computer without any prompting). Analysing the results in these two categories produces some interesting findings.

Regarding the external moderated prompts, which, broadly speaking, are touching in response to physical and verbal prompting by the TA, the ASD children show more touching behaviour in response to prompts in the SM than the FM software. Regarding the system and self moderated prompts (which is measured by the computer prompting the child or by the child touching the computer spontaneously), the touching behaviour in response is greater for the FM than the SM software.

This implies that the ASD children appear to need more externally moderated prompting in the SM; however, from the results of the word gain reported in chapter 4, the child learnt more words from using this software. The conclusion that can be drawn from this is that children with ASD will learn new words when taught using software in an adult-moderated learning environment, as supported by Heimann et al (1995) (see discussion and chapter 8).

Another reason why there were more system and self moderated prompts when using the FM software could be due to the inactivity of the children, and may have lead the TAs to feel that they needed to encourage the children to use the program. What can be concluded from these results is that ASD children appear to need externally motivated prompts in addition to computer prompts in order to use the SM computer program successfully; which may be due to the content structure and the type of program (see chapter 8 for more details).

FIGURE 5.8: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT FOR THE FM SOFTWARE (ASD)

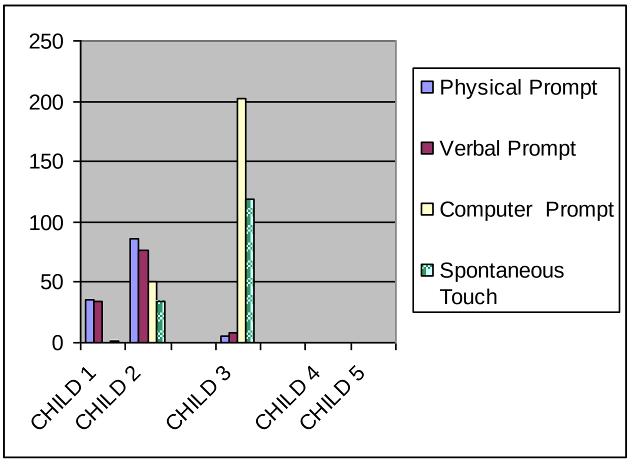
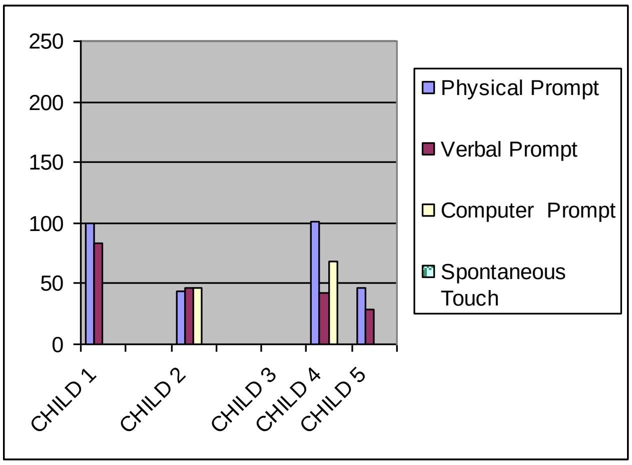


FIGURE 5.9: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT FOR THE SM SOFTWARE (ASD)



CH4 and CH5 were absent from session FM, and CH3 from the SM session

Assuming that the probability of the child touching the computer screen following a given prompt does not affect the probability of him/her touching the screen in response to another type of prompt, it was possible to compare the frequencies of touching in response to different prompts in children 1 and 2 using X^2 tests. The separate X^2 tests for children 1 and 2 on the distribution of different types of touching behaviour in the individual categories (physical prompt, verbal prompt, computer prompt and spontaneous touch) were for child 1 where X^2 =2.902 and for child 2,where X^2 =2.573.

5.3.2(B)) Frequency of Touch Behaviour following Different Types of Prompt (TD)

In the TD children, there are noticeably more frequent spontaneous touches for the FM software; whilst the SM software recorded higher levels of touching in response to computer prompts (see figures 5.10 and 5.11). This was unsurprising, as the SM software had in-built computer prompts. Few physical and verbal prompts were recorded for either software program.

FIGURE 5.10: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPTS FOR THE FM SOFTWARE (TD)

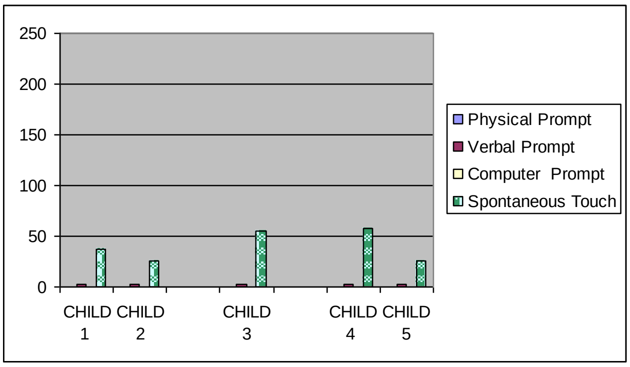
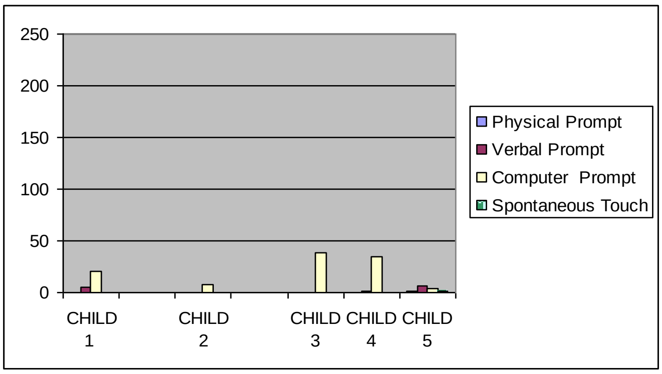


FIGURE 5.11: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPTS FOR THE SM SOFTWARE (TD)



5.3.3 Stress and Boredom (Engagement)

The data in this section were first analysed for the duration of any boredom and stress behaviour (hand movement, flapping, vocalisation and negative affects, such as the participant engaging in self harm) and then coded for the number of episodes of each type of behaviour, then the duration and percentages of the behaviour were calculated. The results will be presented in sections 5.3.3(A) and 5.3.3(B) for the ASD and TD children respectively.

5.3.3. (A) Boredom and Stress Behaviour (% Over Frequency and Duration) (ASD)

The results for the ASD children showed more episodes of boredom and stress when using the SM than the FM software (as shown in figures 5.12 and 5.13). The total duration of the boredom and stress episodes is illustrated in tables 5.12 and 5.13. Boredom and stress was also calculated by summing up all of the negative behaviour measured as:

$$\frac{\text{Time of negative behaviour}}{\text{Total time session}} \times 100$$

TABLE 5.12: RESULTS FOR THE DURATION OF BOREDOM AND STRESS FOR FM (ASD)							TABLE 5.13: RESULTS FOR THE DURATION OF BOREDOM AND STRESS FOR SM (ASD)						
CH	**Hand movement**		**Vocalisation**		**Negative affect**		**CH**	**Hand movement**		**Vocalisation**		**Negative affect**	
	N	D	N	D	N	D		N	D	N	D	N	D
1	1	3	1	8	4	36	1	5	72	13	94	3	35
2	2	5	1	8	0	0	2	10	50	8	35	1	13
3	0	0	0	0	0	0	3	0	0	0	0	0	0
4	0	0	0	0	0	0	4	8	45	11	123	5	29
5	0	0	0	0	0	0	5	12	108	18	114	6	74

CH=Child

N= Number of episodes

D= Duration of episodes (in seconds) e.g. the number of episodes of hand movement for child 1 (for the SM software) is 5, and the total duration of all the episodes is 72.

Figures 5.12 and 5.13 illustrate a higher percentage of boredom and stress in the SM than the FM software. A direct comparison was only possible for children 1 and 2 (who were present in both computer programs). Child 3 in the FM software had no recorded boredom and stress, which indicates that he was most engaged with this FM software (although he was absent from the SM software, so no comparison could be made).

FIGURE 5.12: PERCENTAGES OF BOREDOM AND STRESS FOR THE FM (ASD)

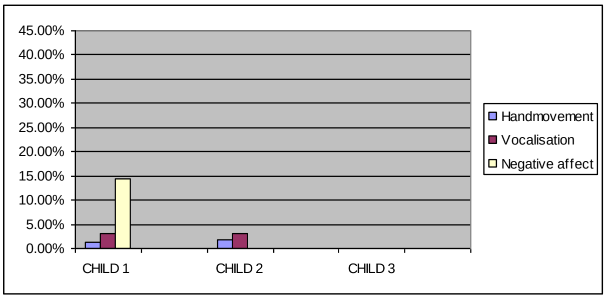
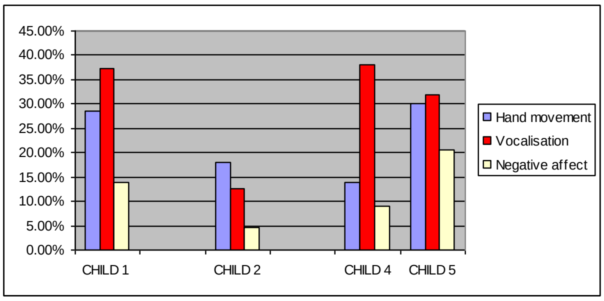


FIGURE 5.13: PERCENTAGES OF BOREDOM AND STRESS FOR THE SM (ASD)



CH4 and CH5 were absent from the FM session and CH3 from the SM session

5.3.3. (B) Boredom and Stress Behaviour (% Over Frequency and Duration) (TD)

In contrast to the ASD children, the TD children recorded low levels of boredom and stress. Tables 5.14 and 5.15 showed only limited episodes of this behaviour in child 5 for the FM software, while, for the SM software, children 1 and 5 recorded some level of this behaviour.

TABLE 5.14: RESULTS FOR BOREDOM AND STRESS FOR THE FM (TD)							**TABLE 5.15: RESULTS FOR BOREDOM AND STRESS FOR THE SM (TD)**						
CH	**Hand movement**		**Vocalisation**		**Negative effect**		**CH**	**Hand movement**		**Vocalisation**		**Negative effect**	
CH	N	D	N	D	N	D	CH	N	D	N	D	N	D
1	0	0	0	0	0	0	1	0	0	1	4	0	0
2	0	0	0	0	0	0	2	2	2	0	0	0	0
3	0	0	0	0	0	0	3	0	0	0	0	0	0
4	0	0	0	0	0	0	4	0	0	0	0	0	0
5	0	0	1	2	0	0	5	1	3	1	2	0	0

CH=Child

N= Number of episodes

D= Duration of episodes (in seconds) e.g. the number of episodes of hand movement in child 5 (for SM software) is 1, and the total duration of all episodes is 3.

In contrast to the percentage of the duration of boredom and stress in the ASD children, the TD children recorded limited levels of boredom and stress (as shown in tables 5.17 and 5.18; see the previous section for the ASD results). The implication of this is that the FM and SM can engage TD children.

Some of the findings of this empirical study form the basis of the design standards. Discussion of these results and the design standards are in chapter 8.

5.4 Chapter Summary

This chapter discussed the observation investigation. This method was employed to observe two groups of children using two computer programs as part of an evaluation process. The investigation emanates from the investigation into how to design appropriate computer programs for children with ASD, with a view to standardising their design. The significance of this chapter to this investigation is that it provides a direct means to see, at first-hand, the children using the computer program as well as providing a forum for comparing the interaction between children with ASD and a particular computer program with that of TD children. It focused on children at the more severe end of the spectrum of this disorder (who are usually not researched due to the severity of their condition), bringing them to the forefront of the research. It offers first-hand information on the interaction between the child and the computer, and gives important information about the child's actions and disposition whilst using the program. This venture, combined with the two other empirical studies to follow (in the next two chapters), postulates the design standards (recommendations) based on the findings of the study; which are discussed in chapter 8.

Chapter 6

EMPIRICAL STUDY iii: INVESTIGATING ATTITUDES

6.1 Introduction

The next empirical study investigation adopts an investigatory approach, soliciting the attitudes of educationalists in Autistic Spectrum Disorder (ASD) and Human Computer Interaction (HCI) professionals towards the two computer programs: 'Speaking for Myself' and 'Sentence Master'; in the light of the research question - 'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?' – This chapter explores further how to design Educational Computer Programs (ECP) for children with ASD.

This chapter is divided into four parts, the first of which introduces the attitude questionnaire as a data collection method, discussing why this method is considered suitable for the task of obtaining the attitudes of the participants (as a method for determining which of the two computer programs employed in this study is considered better suited to children with ASD). In the context of the research problems, the literature on similar studies was likewise examined. The processes and procedure of this method, the results and discussion ensue.

The rationale for employing the attitude questionnaire is that the data gathered using this technique can be used to provide more details on the evaluation of the computer programs based on the participants' attitudes to them. The attitude questionnaire, as a data gathering tool, can help to obtain the participants' attitudes towards a product.

The aim of empirical study iii (as with empirical studies ii and iv, discussed in subsequent chapters) is to 'Evaluate the appropriateness of educational literacy computer programs designed to facilitate early reading skills in children with ASD by obtaining the attitudes of the participants (Ardehali et al., 2003).

The hypotheses tested in this empirical study investigation are:

(H1) The computer programs (FM and SM) are functional (usable/easy to use)[1] for children with ASD.
(H2) The content and structure of the computer programs (FM and SM) are appropriate for children with ASD.
(H3) The computer programs (FM and SM) support the learning style of children with ASD.
(H4) The computer programs (FM and SM) will promote positive user experience[2] in children with ASD.

6.2 Method

Attitude questionnaires were employed as the data gathering tool to test the attitudes of the participants based on the hypotheses, stated above, regarding the two computer programs employed in this study. The attitude questionnaires are based on 25 items with Likert scale responses (appendices E and F). The participants were asked to select appropriate answers from a list. The semantic differential method[3] was employed to design these questionnaires. The benefit of this method is that it is easy to interpret and rate the responses. The questions are rated according to a five-point Likert scale from ‘strongly agree’, 'agree', ‘strongly disagree’ to 'disagree ' and ‘unknown’. Likert scales of differentiation based on the five point scale measured the participants’ attitudes towards/opinions about the two computer programs employed in the study.

6.2.1 Participants

The participants in the attitude questionnaire were 2 support teachers /teaching assistants (TAs) and 2 HCI professionals (HCs). The TAs were teaching assistants in the special school, where this project was conducted, whilst the HCs were HCI professionals within the University of this research. The participants were asked to use the computer program before completing the questionnaire, interviews of the participants then followed, in order to give a greater level of depth and detail to this research(see interview B in the next chapter).

6.2.2 Procedure

Attitude questionnaires were employed in this study as a data gathering tool for obtaining the attitudes of the participants (the support teachers) towards the computer programs employed in this study. The attitude questionnaires (appendices E and F) are based on the 25 items on the Likert Scale. The responses recorded were graded using the ordinal level of measure (or scale). The attitude questionnaire (see an example in figure 6.1) was divided into several parts in order to separate the two types of question. Questions 1-18 and 22-25 require a response to a positive-based question which asked questions which require a positive or

[1] Functional means that the computer program should be easy to use and learn by the users, who, in the context of this study, are children with ASD.

[2] Positive user experience in the context of this study means that the users have enjoyable encounters/experiences whilst using the computer program.

[3] Semantic differential is a scale measuring meanings of determining extremes between objects or attitudes (e.g. good to bad, active to passive).

negative type of response, whilst questions 19-21 require a response to a negative-based question (the reason for this approach is discussed below).

The results of the attitude questionnaires were analysed by investigating the data collected to look for any similarities in attitude both across and within the groups of participants, in relation to positive attitude, negative attitude and the questions being unknown. This data is presented in a tabular/image format below. The mean scores were recorded for the attitude questionnaire completed by both participants (the teaching staff who participated in this study), as these provide an effect way of determining the value of the attitudes recorded in both questionnaires, as it also works as an interval level of measurement of the results obtained from the attitude questionnaires. They consist of twenty-five questions divided into four sectors - usability, content/structure, learning style and general. The questionnaires were designed with two types of response; positive and negative.

The positive type (questions 1-18 and 22-25) is based on positive-based responses, containing statements such as:

- The program is easy to use.
- The colour scheme used on the interface is adequate.

The negative type (questions 19-21) is based on negative-based statements, containing statements such as:

- It is difficult to find your way around the program.
- You feel lost when using the program.

FIGURE 6.1: SAMPLE OF THE LIKERT SCALE (TAKEN FROM THE ATTITUDE QUESTIONNAIRE)

System/functional requirements					
The program is easy to learn	Strongly agree ☐ 1	Agree ☐ 2	Disagree ☐ 3	Strongly disagree ☐ 4	Unknown ☐ 5

The positive- and negative-based questionnaire format was employed in order to triangulate the attitude statements made, thereby providing two ways of viewing the computer program (negative and positive). This process provides a balanced perspective of the attitudes of the participants as well as avenues for triangulating their opinions about the systems employed, providing a fuller picture of their attitudes.

The participants were interviewed after completing the attitude questionnaires in order to obtain a detailed overview of the computer programs. The interviews help to shed some light on the appropriateness of computer programs as teaching tools for the subjects involved in this study and provide a way of determining the children's reaction to the computer programs, with regard to the usability and usefulness of the questions (H1).

Measures

The measures applied in the attitude questionnaire are determined in three levels, whereby the three measures recorded positive, negative and unknown. These measures were applied to the four categories of question, which include usability questions (twelve questions), content and structure questions (five questions), learning style questions and general questions. Hypothesis 1 tested usability issues, and hypothesis 2 tested the content and structure to determine the suitability/appropriateness for children with ASD. Hypothesis 3 tested the learning style used in the computer programs and hypothesis 4 tested the children's learning experience. The analysis of the attitude questionnaires was based on the information-seeking approach, which is discussed in the following lists (see table 6.1 below). The parameter employed in this study was considered beneficial since it added more detail to the data analysis (see the discussion section below).

TABLE 6.1: ANALYSIS OF ATTITUDE QUESTIONNAIRES

LEVELS OF ANALYSIS	PROCESSES AND PROCEDURE
Level 1	Summary/précis of attitudes
Level 2	The results are sub-divided into four categories (usability, content/structure, learning style and general)
Level 3	Agreement between the attitudes of the TAs and HCs (inter-group agreement and disagreement) Disagreement between the attitudes of the TAs and HCs Different levels of agreement between the attitudes of the TAs and HCs

Materials

The attitudes questions are based on 25 items with Likert Scale responses. The items from the attitude questionnaires were adopted from the previous studies and literature review, which discussed the Heuristics evaluation method (Nielsen, 1994) and the Rare Event theory (REL; Nelson and Tjus, 1997; Nelson et al, 2001). The former is an off-the-shelf discount usability evaluation method (Nielsen and Mack (1994). Molich and Nielsen (1990) devised this method in response to the need for cheap, cost effective methods that could be used by small companies that do not have the facilities, time or expertise to conduct usability engineering.

The heuristics evaluation method is a usability engineering technique employed in determining usability problems within a computer interface, which may be applied during the iterative development process of software development. The Heuristics evaluation method can be use as a formative (prior to a program being designed), developed or summative (subsequent to a computer program design) method for evaluating a computer program. The purpose of this evaluation is to generate evaluation questions from Nielsen's Heuristic method (Nielsen and Molich 1990, Nielsen 1994). REL, like the Heuristics evaluation method, was incorporated into the attitude questionnaires (Nelson and Tjus, 1997, Nelson et al, 2001). This theory, which aims at improving learning opportunities for children with ASD and learning difficulties, advocates what it calls a "Tricky mix"; that is a combination of five elements to be considered when designing multimedia computer programs for children with learning disabilities (see chapter 8).

The questions asked in the attitude questionnaire are typical questions, covering issues based on the program's functional requirements, the interface (design considerations), the terminology and system information provided in the programs, the navigational issues, attention and motivation, the program/s appropriateness for developing reading skills (learning new words) and the subjects' (children with ASD who took part in the study) reaction to the programs.

Pilot study

The piloting of the attitude questionnaire was undertaken by two colleagues, who gave comments and feedback on the content and wording of the attitude questionnaires. This venture offered the researcher the opportunity to clarify the questions/statements in the questionnaire, and check their relevance. The pilot study was conducted using a dummy run of the attitude questionnaires. The pilot study helped me to refine the processing and implementation of the data collection. Another benefit of the pilot study was that it provided the opportunity to test the questionnaire prior to the actual process.

Listed below (Table 6.2) are some of the recommendations and suggestions provided prior to the application of the attitude questionnaire.

TABLE 6.2: SAMPLE OF THE RECOMMENDATIONS

PROBLEMS	ACTION TAKEN	COMMENTS
The participant was unclear about what to do with the program.	The training of teachers. The researcher needs to demonstrate to the teacher how to use the program.	Amendment was implemented
Questions 2 and 5 of the questionnaire meant the same thing to the participants.	Question 5 of the questionnaire was deleted.	Amendment was implemented
Questions 8 and 9 of the questionnaire meant the same thing to the participants.	The researcher left these in place, as these were different issues to which the researcher wanted responses.	No amendment was made to the questions
The participant needed three sessions with the computer program.	The researcher needs to give the participant flexibility to have as many sessions with the computer program as they felt they needed.	The amendment was implemented
The participant made a few comments that showed a lack of familiarity with certain words; the words 'terminology' and 'feedback' were misunderstood.	This was left as it was by the researcher, as this may be due to a lack of familiarity with the issues that surround children with ASD.	No amendment was made

6.3 Results

The results are presented in three sections, each discussing one of the 3 levels of data analysis outlined above. Section one discussed level 1 (summary of attitudes), section two discussed the level 2 results (in four categories: usability, content and structure, learning style), and section 3 discussed the level 3 results (interpretation of agreement and disparities; comparing individual and inter-group agreement and disagreement). The scores for the questions are based on the Likert scale, where 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree. The scale was reversed in questions 19 to 21, where 1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree. This method was employed to triangulate the attitude questions/statements and to promote vigilance in the participants as they complete the questionnaire (in other to sustain their attention and to ensure that the response is not rushed or guessed, since, reversing the order of the scale (from positive to negative) will introduce an element of surprise, thereby gaining their attention).

Summary of the results (level 1)

A summary of the attitude results (see figures 6.2 and 6.3) indicates positive attitudes from both towards the software but more positive attitudes among the TAs towards both pieces of software, with similar attitudes of 19 and 22 positive scores (in TA1 and TA2) for the FM software and scores of 17 and 21 for the SM software. The scores recorded by the HCs for the software FM and SM were less positive, with scores of 16 and 6 (in HC1 and HC2) for software FM and 8 and 16 for software SM. No negative attitude was recorded in HC2 towards the SM computer program.

FIGURE 6.2: SUMMARY OF THE ATTITUDES OF THE TAS AND HCS TOWARDS THE FM

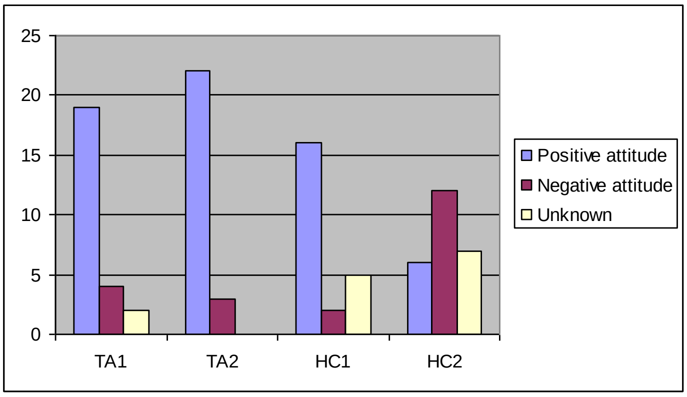
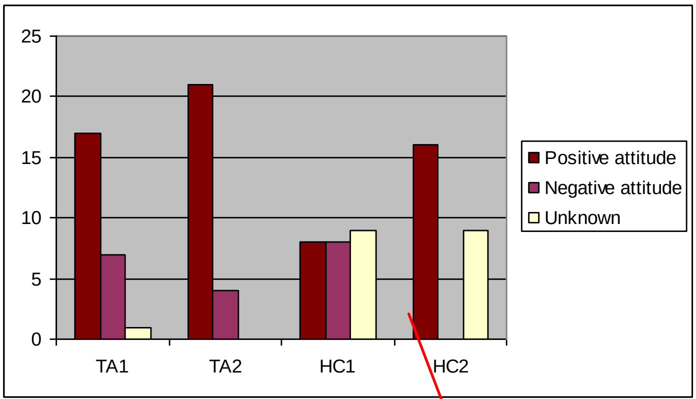


FIGURE 6.3: SUMMARY OF THE ATTITUDES OF THE TAS AND HCS TOWARDS THE SM



No negative attitude was recorded in HC2

Examining the summary of the figures depicted above in greater depth by taking each individual group, statistically, from the results for questions 1-18 and 22-25 (the positive-based questions), TA1 has a mean score of 2.77 for the SM software and 2.77 for the FM, indicating similar positive attitudes towards both programs (see tables 6.29 and 6.30). For TA2 for the SM software, the mean score is 2.91, and 2.95 for the FM software. From the mean scores, TA2 preferred the FM computer program, whilst TA1 had the same attitude towards both types of software. For the negative-based attitude questions (19-21), TA1 recorded a mean score of 3.00 for both computer programs, whilst TA2 recorded a 2.33 score for both computer programs, indicating similar attitudes towards both programs.

TABLE 6.29: MEAN SCORES (FM) QUESTIONS 1-18, 22-25			**TABLE 6.30: MEAN SCORES (SM): QUESTIONS 19-21**		
ID	**Mean Score SM**	**Mean Score FM**	**ID**	**Mean Score SM**	**Mean Score FM**
TA1	2.77	2.77	TA1	3.00	3.00
TA2	2.91	2.95	TA2	2.33	2.33

In the HC group, the mean scores recorded for the positive-based attitude questionnaire (for questions 1-18 and 22-25; see tables 6.31 and 6.32) show that HC1 preferred the FM computer program, with a mean score of 4.23, whilst, for the SM software, HC1 scored 1.73. HC2 recorded a mean score of 2.14 for the SM software and 1.73 for the FM software, indicating HC2's preference for the former. In the negative-based attitude questionnaire (questions 19-21; see Appendix O), HC1 recorded a mean score of 1.67 for the SM software and 2.33 for the FM. HC2 for the SM software scored a mean of 1.00 and 2.33 for the FM software, indicating that HC2 (in the negative based section of the questionnaire) preferred the SM computer program.

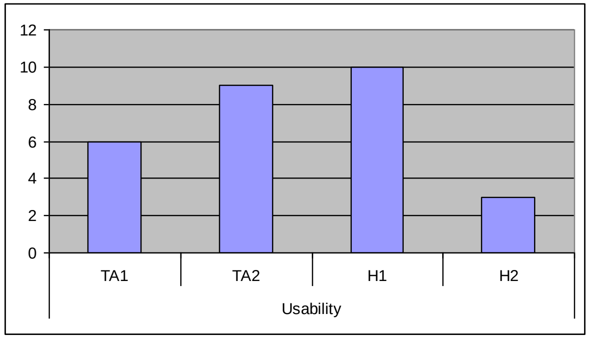
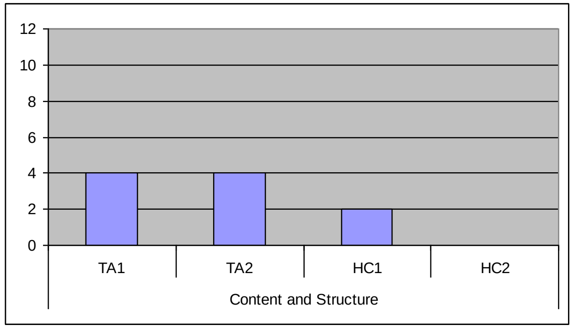
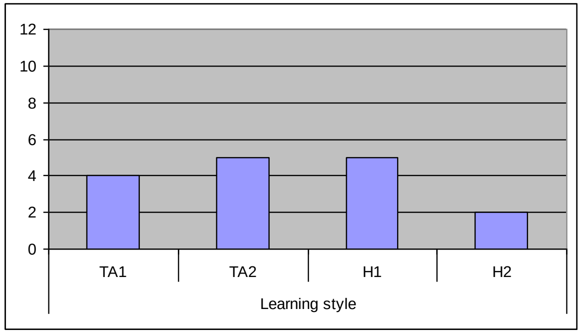
TABLE 6.31 MEAN SCORES (FM) QUESTIONS: 1-18, 22-25			**TABLE 6.32 MEAN SCORES (SM): QUESTIONS 19-21**		
ID	**Mean Score SM**	**Mean Score FM**	**ID**	**Mean Score SM**	**Mean Score FM**
HC1	1.73	4.23	HC1	1.67	2.33
HC2	2.14	1.73	HC2	1.00	2.33

Reviewing both mean scores of the two groups (by summing up the total mean scores), it was observed that the TAs preferred the SM program, whilst the HCs preferred the FM.

Results in four categories (level 2)

An examination of the attitudes in four categories in the computer program FM (usability, content/structure, learning style and general) gives a more detailed picture of the attitudes. In figure 6.4, of the twelve usability questions, the participants noted good levels of positive attitude across the board, with TA2 and HC1 recording 9 and 10 positive responses to the twelve questions asked, respectively. In the content/structure attitude questions (see figure 6.5), out of the four questions asked, the TAs recorded 4 positive responses each, whilst HC2 recorded two positive attitudes, while H2 recorded none. In figure 6.6, of the seven attitude questions asked, TA1, TA2 and HC1 recorded good, positive scores of 5, 6 and 5 respectively. For the general question (not displayed), only TA2 recorded 2 out of the two questions asked.

USABILITY ATTITUDE, CONTENT/STRCTURE AND LEARNING STYLE IN THE TAS

FIGURE 6.4: USABILITY ATTITUDE – FM	**FIGURE 6.5: CONTENT/STRUCTURE - FM**	**FIGURE 6.6 : LEARNING STYLE –** FM
		

Comment: there are 12 usability questions in total: four about content and structure, and seven about learning style

In contrast, the scores for the SM software from the 12 usability questions were 8 and 10 in TA1 and TA2, whilst HC1 recorded 1 and HC2 7 positive attitudes (in figure 6.7), only reflecting a lower score in the HCs group. For the structure questions (see figure 6.8), for the four questions asked in this category, the positive scores recorded were 3 and 4 for TA1 and TA2 and the same scores were recorded for the HCs group. Although the learning style (see figure 6.9) questions were mainly applicable to the TAs, the same questions were also put to the HCs to obtain their views as well as for comparison purposes. The scores recorded were for the seven attitude questions asked. The TAs recorded four and five positive attitudes, whilst the HCs recorded four and three positive attitudes, respectively. For the two general questions asked, no positive attitude was noted in HC1, and 2 were noted in HC2 in TA 1 and 2. Both TAs recorded two positive attitudes to these questions.

USABILITY ATTITUDE, CONTENT/STRCTURE AND LEARNING STYLE IN THE HCS

FIGURE 6.7: USABILITY ATTITUDE - SM

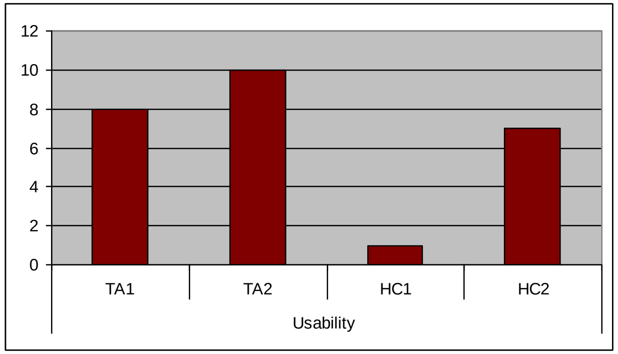


FIGURE 6.8: CONTENT/STRUCTURE - SM

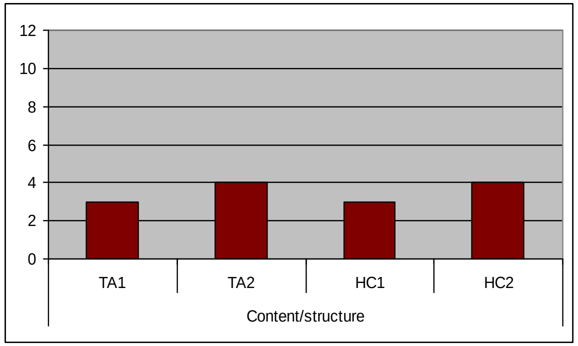
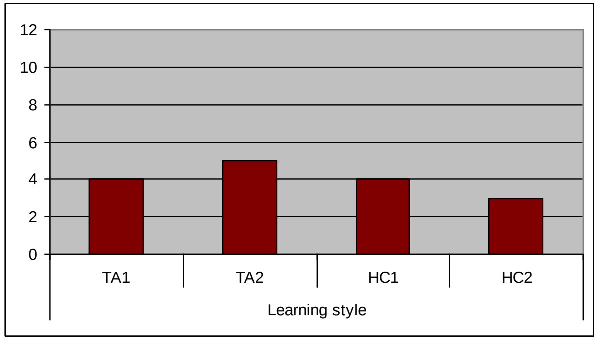


FIGURE 6.9: LEARNING STYLE - SM



Agreement and disagreement (level 3)

The results of the attitude questionnaire were also examined for agreement and disagreement (tables discussed in the reminding of this chapter can be found in appendix O). The results revealed that, using two sets of participants, and four categories (usability, content and structure, learning style and enjoyment/general questions), the significance of examining the similarities and disparities between the results is that it gives a general idea of the thread of the attitudes of the participants, which in turn was adopted in the standards developed to facilitate the design of appropriate educational early literacy software for children with ASD (see chapter 8).

Usability category

In the usability category, the agreement found shows that there was some agreement on the usability of the software. In the FM software, the TAs and HCs agreed in their separate group that the FM was easy to use; (see appendix, table 6.3), both TAs agree on three of the six questions that the software was easy to use, whilst, in the HC group, the agreement recorded was for two out of the six questions. The FM was easy to use in three questions, whilst in the HCs, only one agreement was recorded. The conclusion for the TAs regarding the FM and SM software is that the usability category is positive and, in the HCs, the FM was more usable than the SM.

A detailed evaluation of the attitude questionnaire results revealed inter-group similarities and disparities between tables 6.3 and 6.4 (see appendix O). In the SM software, tables 6.5 and 6.6 show that the TAs in the above table agreed positively on the three questions (see appendix O). The HCs had one attitude agreement; however, there was no similarity in attitudes across the two groups.

Content and structure

In the questions inquiring about the attitude towards the content and structure of the computer program, tables 6.7 and 6.8 (see appendix O) present a different picture to the TA group, agreeing about favouring the computer program FM, with four positive attitudes to the four questions asked. The reverse was noted in the HC group, with only two agreements noted; both were negative attitudes towards the computer program, although there was agreement across the groups, but the attitudes differ between those of the TAs who favour the program content and structure, and the HCs who did not.

Tables 6.9 and 6.10 recorded three positive agreements (see appendix O) in the attitudes to the structure and the content of the SM program (see appendix O). The TAs recorded three similar positive attitudes, whilst the HCs recorded two positive attitudes to the questions asked in this category. None of the attitudes recorded similar attitudes across the groups.

Learning style attitude questions

In tables 6.11 and 6.12 (see appendix O), of the seven questions asked, the learning style attitude questions produced three agreements in the TAs group; two positive agreements and one negative. In contrast, the two agreements in attitude found in the HC group were positive. A cross-group agreement was not recorded, although, in question twelve, the two groups had inter-group agreement, with disagreement across the board; the TAs' attitudes were negative and the HCs group was positive.

In the SM computer program, the agreements in attitude found in the learning style from the seven questions asked showed that the participants in the TAs group were in agreement three times (table 6.13, see appendix O), whilst, in the HCs group, no agreement was noted (table 6.14, see appendix O).

In the FM software, the results (see tables 6.15 and 6.16 in appendix O) indicate that, of the two general questions asked, the participants in the TAs group recorded only one agreement, which was positive. The HCs had no agreement about this software.

Enjoyment questions

In the SM computer program (tables 6.17 and 6.18, see appendix O), the agreement between the attitudes found in the enjoyment/general questions showed that, for the two general questions, the participants in the TAs group recorded only one agreement, which was positive. The HCs had no agreement regarding this software.

There was a disparity between the attitudes of the professionals towards both pieces of software; with one professional strongly disagreeing and the other agreeing. Another level of disagreement was based on some of the questions being left unanswered (the scores of '0' were not recorded). Tables 6.19 and 6.20 (see appendix O) show the disagreements between the attitudes of both groups regarding the FM software, and eight disagreements in total was recorded for the twenty-five questions asked.

There was one area of disagreement (tables 6.21 and 6.22, see appendix O) for the SM software in the TAs group, where seven disagreements were noted. In the HCs group, only one disagreement was recorded (however, the HCs recorded no response to six questions). It is interesting to note that, for this software, whilst one of the TAs was positive, the other had the reverse attitude towards the product. There was more disagreement between the attitudes towards the SM program compared to the FM.

The attitudes that were similar for the TAs and HCs were also noted in the FM software (see tables 6.23 and 6.24 in appendix O). The TAs had different levels of agreement over the five questions asked; in table 12 (see appendix O); the TAs recorded a positive response (agreeing with the questions asked positively).

According to Table 6.25 (see appendix O), the TAs recorded five positive responses; although the level of positives differs (a score of 3 represents/means agree, a positive response, while 4 means strongly agree), a higher positive response, in the HCs group (see table 6.26 in appendix O), and only one question recorded a different level of agreement, with a score of 4 (strongly agree) and 3 (agree).

Discussion of these results and recommendations are in chapter 8

6.4 Chapter Summary

This chapter discussed the attitudes of the participants (2 teaching assistants and 2 Human Computer Interaction professionals) in this empirical study, which aims to investigate the standardisation (providing guidance for the design and development processes) of educational computer software for children with ASD. The attitudes of the participants in this investigation were examined in the light of the hypotheses (see above). This chapter provides a concrete foundation for the standard proposed in chapter 8. The significance of this investigation is that it provides a forum in which the attitudes of professionals in educating ASD children and HCI professionals towards the computer programs are obtained; in the same vein, it provides a tool for facilitating the development of a standard for designing appropriate computer programs for this populace,

Chapter 7

EMPIRICAL INVESTIGATION iv: ELICITING OPINIONS (INTERVIEWS)

7.1 Introduction

The next empirical study (IV) is based on eliciting the views of the participants from two sets of interviews. Since children with Autistic Spectrum Disorder (ASD) cannot relay their experiences of their interaction with the two computer programs employed in this investigation, an alternative had to be considered. One way of obtaining the views of the children and thereby measuring the child-computer interaction (based on user experience) is to elicit the views of the classroom assistants who were the facilitators in this research to represent the children, as suggested by Hetzroni and Tannous (2004). Interviews were conducted as the method for obtaining the experiences of the children as well as the opinion of the support teachers regarding the appropriateness of both computer programs in supporting children with ASD in learning to read.

The research question (research question A; a continuation from the previous chapters) - *'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'* - is examined in greater depth; motivating an additional research question (research question B) '*How can Educational Computer programs (ECP) be improved to support learning to read in children with ASD, with reference to the two ECPs ('Speaking for Myself' and 'Sentence Master') investigated?'* .The rationale for employing the interview method and the preference for semi-structured interviews is based on the fact that this approach to interviewing is flexible, adaptable and reduces the loss of vital information that could be missed in a structured interview, even though there may be some degree of irrelevance during an informal interview process. Other reasons why the semi-structured interview method was employed in this investigation include the fact that it is interactive, provides a greater depth of understanding of a situation and leaves the interviewer better informed, as stipulated by Denzin and Lincoln (1998). The benefit of this method is that it provided this project with detailed information that may have otherwise been ignored without the level of depth that this approach provided; for example, the details of what the children liked or disliked about the computer programs evaluated in this inquiry could be obtained from the interview sessions.

The enquiry employed interviewing as a research method because a reliable means of explaining the test results and a method of evaluating the computer programs employed in this investigation was required. This can only be achieved by obtaining explanations from the participants in the tests about issues that may have arisen during the intervention phase of this research, which otherwise would have been neglected. This investigation required an understanding of the issues that may have arisen during the test situation. These have only come to light because the participants were asked about them in the interview session.
The interviews will elucidate the unlisted issues, which include:

- Throwing light on the professionals' opinions about the appropriateness of the computer programs employed in the investigation.
- Clarification of the attitude questionnaire results.
- Elicitation of the opinion of the participants regarding the benefits and limitations of the computer programs employed in the research.
- The limitations of the programs with a view to eliciting recommendations on how they could be adapted for ASD users.

This chapter is organised into two sections (I & II). The first section discussed the interviews with two sets of professionals: the educationalists (teaching assistants (TAs) and Human computer Interaction professionals (HCIs)). The second section focuses on the recommendation meetings held with the communication assistant and the ASD coordinator. Sections I & II discussed the research question that the interviews aim to address, the interview processes and procedure, and the results.

Discussed below are the processes, procedures, findings and discussion of these interviews. The next part discussed the second set of interviews, followed by a detailed discussion of all of the findings from both parts (interviews I & II).

7.2 Interviews I (Eliciting the Professionals' Opinions)

Interview I was conducted with the TAs. Detailed below are the process, procedures and findings noted in these sets of interviews.

7.2.1 Method

The semi-structured interview method was employed in this investigation. Two types of interviews were employed to shed some light on the respondents' views of the computer programs involved in the enquiry. The interviews were aimed at eliciting the professionals' views about the suitability of the computer programs employed in the investigation, clarifying the attitude questionnaire results and elucidating the test and intervention results (see chapters 5 and 6).

The second set of interviews is a form of consultation and requirement-gathering process, which is a semi-structured way of obtaining the view of professionals in ASD on how best to design an appropriate computer program to teach reading to children with ASD.

The other aim in conducting the interviews is to obtain the design principle proposed (which forms the basis of the development of the design standards / guidelines, discussed in chapter 8) to suit the requirements of children with ASD. The aim of this exercise is to collate the information about the design preferences from the perspective of the subjects and their educators.

The measures to be investigated in the interview data include:

- Positive features of the computer programs
- Negative features of the computer programs
- Recommendations about what is needed in the computer programs

7.2.2 Participants

In interviews I, the participants in the interviews were the 2 TAs and ICT Co-ordinators that help to manage the children who took part in this research. The second set of interviews (interview II) was held with 2 HCI professionals. The interviews with the first group (the educationalists) were conducted in the school investigation (the specialist school), whilst the interviews with the second group were conducted on the university campus.

7.2.3 Procedure

This research employed the semi-structured interview method. Two sets of interviews were conducted in this investigation. The interviews were employed as a tool for investigating the benefits and limitations of computer programs in teaching new words to children with ASD. The participants in these interviews included 2 TAs (the facilitators of the research) and HCI professionals. The first set of interviews (interviews I) was conducted as part of the data gathering process, the primary aim of which was to obtain the views of the participants (the facilitators and HCI professionals) about the programs employed in this investigation, as well as to clarify the attitudes of the participants (discussed in the previous chapter). The secondary aim of the endeavour (the recommendation interviews) was to elicit the views of the participants about the best way to design appropriate programs for children with ASD.

The first set of interviews (interviews i) was conducted after the ASD teaching assistants and HCI professionals had completed the attitude questionnaires (see chapter 6). The second set of interviews (interviews 2) was part of the requirement gathering exercise. The participants in these interviews included a speech therapist and communication assistant and an autistic unit coordinator.

The materials for the interviews were piece of papers on which the pre-set interview questions were printed (see appendices J and I). Other materials used for the interview sessions included: a Sony portable minidisk recorder (mz-B100), a note pad and a pen for the researcher.

Pilot study

Pilot interviews were conducted with a teacher and computer science lecturers. The participants in the pilot interviews were not part of the main interview. This was to avoid biasing the participants. The pilot interviews involved conducting a dummy run of the interview content and procedures. This pilot interview provided the researcher with the opportunity to amend the content and structure of the interview questions, and revealed that some words were unclear and that some participants lacked familiarity with certain words.

Data analysis process and procedure (interview 1)

The interviews were recorded onto audio tape (see the materials section above) and then transcribed using a word processor. The computer program Nudist 6 (a qualitative data analysis program) was employed to analyse the data. The befit of employing the Nudist qualitative analysis included the fact that it provides good storage and organising facilities to categorise the data as well as proving the themes and threads in the data, as well as good searching tools which help to facilitate the data analysis.

The analysis of the data gathered was completed using the discourse analysis approach. The discourse analysis method is a classic procedure for the analysis of textual materials (ranging from media products or transcripts of interviews), using various steps and procedures. One of the main features of this analysis method is the use of categories (which are derived from theories); these categories are assessed against empirical materials, as noted by Flick (1998). Some of the benefits of employing discourse analysis include the fact that it is a clear analysis tool owing to its detailed procedure, lower ambiguity, with clearly defined rules of application, and a uniformity of categories employed, which facilities the comparison of various empirical s. Some limitations of the discourse analysis method include the fact that this method is expensive, and the process of categorising text based on the existing theories may obscure the view of the data (ibid).

The discourse analysis procedure implemented in this investigation was performed in four steps:
Step 1, defines the material. The interview transcripts from the data collection were analysed in the light of the research question discussed above, using the discourse analysis method.

Step 2, the interview transcripts were examined in the context of the data collection (in relation to the attitudes questionnaires). The interviews help to shed more light on the attitudes recorded (see chapter 6).

In step 3, the data were formalised. The formal characterisations of the data collection process involve looking at the data analysed within the context of the data collection process.

Pertinent questions that these aspects of the data analysis attempt to answer are:

- How were the materials collected?
- What were the protocols of the data collection process?

- How were the protocols followed?
- How did the editing of the transcript affect the text?

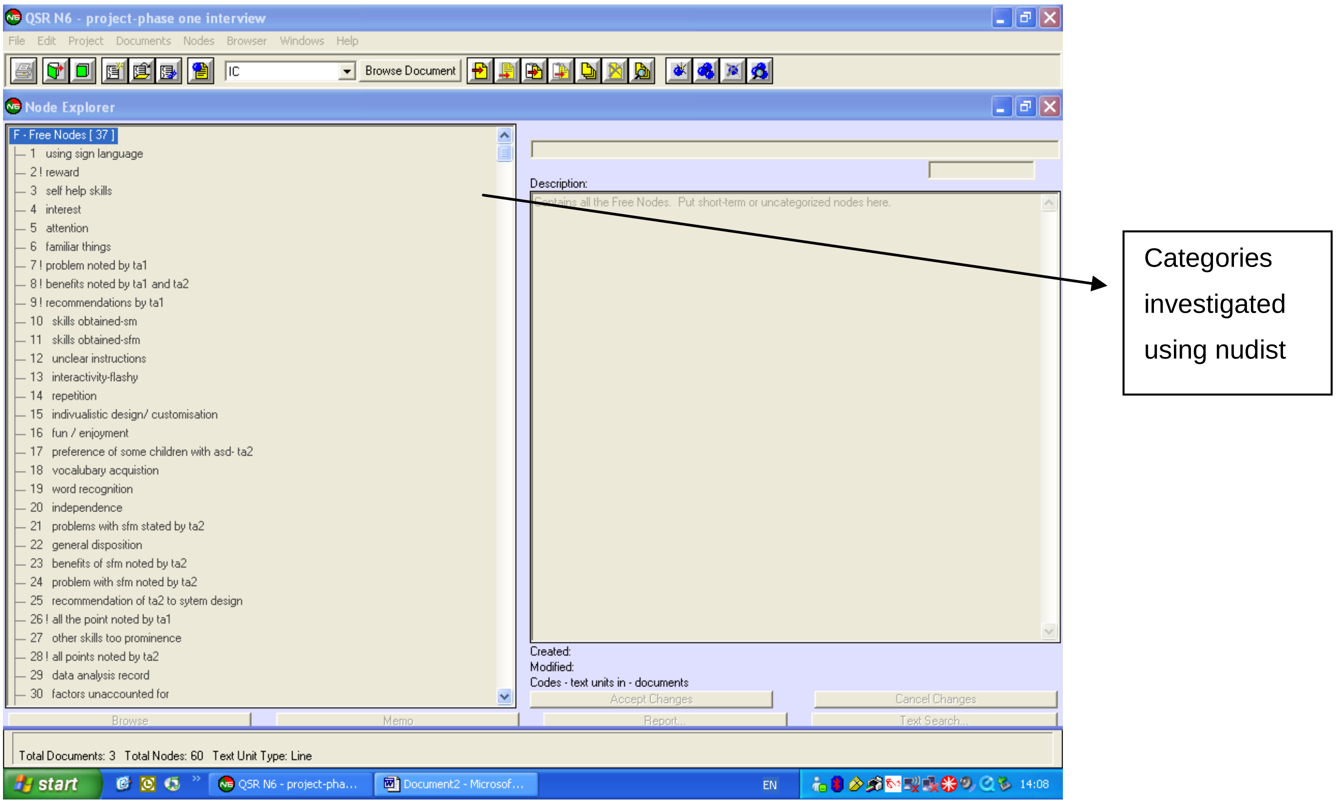
Kitchenham et al.'s (2002) guidelines were employed to facilitate the planning and implementation of the research into software development. The framework, postulated by Kitchenham et al., discussed in chapter 3, examined the experiment context, experiment design, conducting of the experiment and data collection, analysis, presentations and interpretation of the results.

The final step in the qualitative content analysis involves the view of the direction of the data. In this step, the direction of the data analysis is viewed in line with some pertinent questions, such as 'What do I want to interpret in the transcript I have collected?' In this step (step 4), some of the research questions were revisited to facilitate further differentiation on the basis of the theories. Detailed in table 7.1 are the procedures, tasks and locations of the interview results:

TABLE 7.1: DETAILING THE DATA ANALYSIS PROCESS

STEPS	PROCEDURE	TASK	RESULTS
Step 1 Defining the material	Data analysed in the light of the research questions	Q1.Examined research question 1	Detailed in section 7.1
		Q.2 Examined research question 2	Detailed in section 7.1
Step 2 Analysing the situation	Interpretation based on the context of the data collected	Examined the context of the interview	Attitude questionnaire results and interview results
Step 3 Formal characterisation	Kitchenham et al.'s (2002) guidelines were employed to facilitate the planning and implementation of the interviews (see chapter 3).	How were the materials collected?	(Discussed in sections 7.2.1, 7.2.3, 7.3.1, and 7.3.3)
		What were the protocols of the data collection process?	(Discussed in sections 7.2.3 and 7.3.3)
		How were the protocols followed?	(Discussed in sections 7.2.3 and 7.3.3)
		How did the editing of the transcript affect the text?	(Discussed in sections 7.2.3 and 7.3.3)
Step 4 Direction of the data analysis	Examination of the questions pertaining to this aspect of the data analysis	Review of the interpretation of the transcript	(Discussed in section 7.2.3)
		Revisiting the research questions for further differentiation on the basis of the theories	(Discussed in sections 7.2.4 and 7.3.4)

FIGURE 7.1: SAMPLE OF THE CATEGORIES DEVELOPED USING THE NUDIST PROGRAM



7.2.4 Results

The main points from the data obtained from the interview revealed problems with the design of the computer programs employed in this research. The main theme that emerged from the data analysis include a lack of design consideration regarding the core deficits of the learning style of ASD and the fact that their characteristics (their needs and preferences) are not implemented in the computer programs, as identified by Trehin (1994); other themes are discussed below.

The main aim in analysing the interview transcript is to discover the views of the participants regarding the computer programs employed in this study, with the aim of applying the knowledge gained from this venture to a more general sphere (improving the design of ECP) and, hopefully, generalising the findings of this investigation to the design of computer programs for children with ASD.

The research problems that these interviews aim to throw light on include:

- The participants' opinion of the computer programs employed in the enquiry.
- The views of the participants about the suitability of the computer programs employed for children with ASD.
- The clarification of the evaluation questionnaire results.
- Investigating how to improve ECP aimed at supporting reading in children with ASD.
- Evaluating the strengths and weaknesses of the current approaches to the design of reading ECP.

The findings from Interview I

This section discussed the interview results in both computer programs in three categories; the first part discussed problems with the computer programs, listing their good features, and some recommendations proposed by the participants were noted.

In the SM computer program, some of the limitations recorded for both participants are listed in tables 7.2 and 7.3. The key areas that were highlighted by the program include problems with rewards, content and usability.

TABLE: 7.2: PROBLEMS WITH THE COMPUTER PROGRAMS (TAS)

Categories	Problems identified
Usability issues	-Clicking irregularities
Content	-Pictures obstruct words -Words sometimes too cluttered.
Repetition	-Too repetitive even after the word is learnt
Reward	-Reward not immediate
Choices issues	-Limited choices
Repetition	-Too repetitive
Navigation	-You cannot navigate between pages
Other	-Cannot be adaptable to be child-specific

TABLE: 7.3:PROBLEMS WITH THE COMPUTER PROGRAMS (HCS)

Categories	Problems identified
Interface	-Screen size can be bigger - The background is distracting -Visual design is not polished and too simplistic
Usability issues	-Drastic change of interface without warning -The program is too slow -No indication of exit -Menu too complex for a child
Content	-Tasks do not tally with graphics -Theme of the interface does not tally with what is taught
Reward	- Take up time -Can be irritating (after seeing it a few times) -Lack of reward can de-motivate users

In the FM computer program, the key problems areas recorded include usability problems, such as clicking irregularity, the illegibility of the words taught and the lack of rewards (tables 7.4 and 7.5).

TABLE 7.4: PROBLEMS WITH THE COMPUTER PROGRAMS (TAS)

Categories	Direct interpretation
Usability issues	-Instructions about what to do is unclear -Load time delayed -Clicking irregularity
Content	-Inappropriate, confusing use of images
Learning style	-Does not support the way in which ASD children learn
Interactivity	-Lack of interactivity
Reward	No reward
Navigation	-Structure unclear (where to begin and where to end)
Other issues	-The words taught may not be of interest to the child (hence no attention)

TABLE 7.5: PROBLEMS WITH THE COMPUTER PROGRAMS (HCS)

Categories	Direct interpretation
Usability issues	-Clicking irregularity -Unpredictable -No cursor change -No reaction -The icons were not predictive -Incorrect instructions
Content	-The scope of the words taught is extensive
Interface	-The text in some parts of the interface is illegible
Interactivity	-Lack of interactivity
Navigation	-Confusion about on what to click
Other issues	-Presupposes some level of motivation and engagement -No assessment

(From this section onwards, the result tables can be found in appendix O).

The key similarities noted in the results (in the two programs) include: usability problems, content problems and not being autistic-user friendly (lack of ASD learning style). The problems noted of the lack of reward by the TAs (table 7.4) and the excessive repetition (see tables 7.12 and 7.13 in appendix O) reflected some of the problems that these programs need to address in order to be adapted for ASD users.

Tables 7.6 and 7.7 (see appendix O) detailed the good features of the SM program, including the good interface design as well as the good use of interactivity in the program. Tables 7.8 and 7.9 (see appendix O) detailed the good features found in the FM program, which include the skilful use of multimedia as a teaching tool. Tables 7.12 and 7.13 (see appendix O) detailed the omissions in both programs.

The key similarities regarding the proficiencies of both computer programs include the use of varied multimedia and assistive technology tools in the FM program (tables 7.8 and 7.9 in appendix O) and, to some degree, the use of repetition in teaching new words.

The recommendations made by both groups include a better designed interface, limited repetition, more ASD learning styles incorporated into the system, the use of simple language, and the assessment by users at the end of the session (see tables 7.10 and 7.11 in appendix O)..

The recommendations made about both computer programs are diverse. The TAs' recommendation was for brighter font colours to support the ASD child's colour disposition; children with ASD are predisposed to certain colours and more use of animation. Goulden (1998) supported this view. The HCs recommended the use of more sophisticated, polished interfaces for better navigation. All of these views were relevant and taken into account in the designing of the standards discussed in chapter 8.

7.3 Interviews II (Recommendation Consultation)

The second set of interviews was the recommendation and requirement investigative consultation interviews. These interviews were held with professionals in autism (communication and co-ordination) in the specialist school where this study was conducted. The aim of these meetings was to elicit the professionals' views on how appropriate computer programs for children with autism and SLD should be designed.

7.3.1 Method

The semi-structured interview method was employed in this investigation. The second set of interviews is a form of consultation and requirement gathering process, which is a semi-structured way of obtaining the view of professionals in autism on how best to design appropriate computer programs to teach reading to children with autism.

Measures

No measures were applied to the interview apart from noting the points made by the participants and collating these to form part of the requirement specification (in the guidelines discussed in the next chapter).

7.3.2 Participants

The participants in the consultation recommendation interview were the special school's speech therapist and communication assistant and the autistic coordinator (the ICT coordinator was also present).

7.3.3 Procedure

The participants were asked pre-set questions in a semi-structured interview. Their views were elicited on how to design appropriate computer programs for autistic children. The responses to these questions were recorded as recommendations; they formed part of the design standards /guidelines (discussed in chapter 8).

7.3.4 Findings and Recommendations

Detailed below are the recommendations made by the participants. The recommendations provide vital information for facilitating the much-needed set of guidelines for the design of appropriate ECP for children with ASD. The recommendations made by both participants are similar, although greater levels of input were given in the later recommendations (discussed below). These recommendations highlight the pertinent issues that need to be addressed when designing learning computer programs for children with autism and SLD, as illustrated in table 7.14 (see appendix O).

Other recommendations made by the autistic unit coordinator and ICT coordinator include the use of signing. The use of a signer (employing sign language), symbol and speech will be most appropriate methods for autistic programs.

Program content

The recommendation that nouns and position words, such as ‘the’ and ‘because’, should be taught by the program was made in this session.

Teaching approach

In the school employed in the study, a High scope approach (which employs the “choose -do- review method”) is employed, combined with the TEACCH approach (which provides a structured ‘choice’, which is much needed by children with autism). The recommendation made was that a combination of various approaches would be beneficial, excluding semantics; which is the teaching of spelling, which may be too complex when teaching children with autism using conventional methods.

Communication device

For the level of development of the children employed in this study, the photo (photograph) and symbols will be the most viable means of communication. However, the problem with the photo is that it could be ambiguous (confusing and misleading), as a child with autism may, for example, focus on a dot on a photograph rather than the object shown in the photograph. Line drawing and using written symbols was recommended as an effective method to employ which could serve as a substitute for the use of photographs.

Supporting assistive technology devices

A device that allows the usage of various input devices, such as switches, adaptable keyboards and touch screens, could help to promote ICT skills in children with ASD.

Training and tutorials

Parents and teachers could be given training or they could be included in the program tutorial on how to customise the computer programs.

Discussion of both interview results and the recommendations that was made formed part of the design standards / guidelines (see chapter 8).

7.4 Chapter Summary

The interview (interviews I and II) results highlight some of the key issues which need to be addressed in the standardisation of the design of appropriate educational computer programs for children with ASD. Pertinent problems that hinder the users (children with ASD) from fully benefiting from the computer programs were identified, and suggested remedies were recorded and added to the standardization guidelines (discussed in chapter 8). Conducting these interviews enabled the issues to be explored in greater depth than would otherwise have been possible. The processes (conducting the interview, transcribing the data, writing the report) embarked upon in this empirical study was an enlightened, informative and, to some degree, relatively successful venture, since it enabled the exploration of possibilities that would otherwise have been neglected or remain unexplored. These interviews form a crucial aspect of the information-gathering process and are employed in developing a set of standards to facilitate the design of appropriate computer programs for children with ASD.

Chapter 8

DISCUSSION

8.1 Introduction

This chapter will examine the processes, procedures and findings of this project in its totality.
The outline of this chapter, which is discussed in five parts, is summarized below:

The first part commences by examining the research question, ‘What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?’ .This question motivated additional questions and hypotheses (see chapters 4-7), which were aimed at defining and focusing this investigation by examining the issues that need to be explored in the standardizing of Educational Computer Programs (ECP) to support early reading in ASD children.

The subsequent part evaluated two carefully selected computer programs, which serve as a model of typical educational literacy computer software. The significance of this is that it helps to refine the key aspects of the design standard, by investigating aspects of the computer programs that were found to be deficient with a view to producing standards for this research.

The following part discusses the research methodology (underpinning method) employed in the project, reviewing its significance and limitations. The significance of the theories employed is that they provide a way to articulate the methodological issues that need to be considered in order to optimise the methods and techniques employed in the planning and implementation of the investigation. The theories examined and included in this research include learning (psychology), literacy (education) Human Computer Interaction (HCI) and software engineering.

The next part discusses the four empirical studies employed to research this topic. This venture provided varied resources and methods for obtaining pertinent data regarding the content of the design standard proposed in this current research. The first empirical study employed was the pre- and post-tests (empirical study investigation i), which was used to determine whether word gain will be realised after the children with ASD employed two computer programs to learn new words. Subsequently, the video recording (empirical study investigation ii) was implemented to examine the interaction between the children and the software, providing first-hand information about the participants or the phenomena observed. The attitudes (empirical study investigation iii) of the professionals in ASD and HCI results were examined with a view to evaluating the appropriateness (which one was better suited) of educational literacy computer programs designed to facilitate early reading skills in children with ASD. Next is the interview (empirical study investigation IV), which is the last method employed. This method was employed to elucidate the issues relating to the children's performance whilst using the computer programs from the professionals in ASD and HCI's perspectives of the appropriateness of the computer programs employed in the investigation.

The ensuing part discusses the contributions of this investigation to research in the domain of ECP for children with ASD; this contribution serves as a summation of all of the findings of this project. The two contributions made were the formation of the Selection Instruction (SI) for ASD software and the Educational Computer Program Design Standard (ECPSD) for ASD software.

The SI was a preliminary contribution. It was developed to facilitate the selection of efficient computer programs for children with ASD. These instructions can be followed by professionals and the parents or guardians of children ASD who need assistance with selecting appropriate computer programs which will assist their acquisition of early reading (word acquisition) skills. This instruction can be adapted to suit other educational topics.

The ECPDS for ASD software takes into account all of the components (effectiveness, the deficiencies of ASD, the design of tailor-made systems that address individual learning requirements, reading, the learning styles of children with ASD and how they learn to read) and sub-components (software engineering, the design and development of systems, HCI, usability) that are essential to the development of systems to support the development of early reading skills in children with ASD. The ECPDS was developed in an attempt to bridge the gap between how children with ASD learn (as advocated by professionals in ASD) and how to design appropriate computer technology to support and reinforce this endeavour.

8.2 Evaluation of the Computer Programs

Several investigations have recorded the educational and therapeutic benefits of using computer technology with children with ASD, as recorded by Heimann (1993), (1995), Tjus et al. (2001) and Russel et al. (2003). Panyan (1984), in a review of the literature on ASD and computers, noted the potential of computers to facilitate learning in children with ASD, although much of the literature he reviewed provided no evidence of actual success. Colby and Smith (1971) noted that employing a multimedia computer program assisted in stimulating linguistic improvement in children with ASD, and 13 out of the 17 nonverbal children with ASD began using speech for social communication after using the computer program containing 8 games. Nelson et al. (2001) observed that the intervention of a motivating multimedia program might stimulate reading and communication in children with various disabilities. Williams et al. (2002) noted that computer-based instruction was effective in teaching children with ASD to read.

This MURASD project for children with Autistic Spectrum Disorder (MURASD) employed various methods (see chapters 4-7) to investigate standardisating ECP for children with ASD, as discussed below.

8.2.1 Discussion of the Empirical Study Investigation i (Pre- and Post-test).

The aim of the pre- and post-tests is to determine the number of words learnt, as a means of determining the appropriateness of the two computer programs, 'Sentence Master' (SM) and Speaking for Myself' (FM).

The hypothesis tested (peculiar to this empirical study investigation i) is:
H1: 'The educational computer programs ('Speaking for Myself (FM)' and 'Sentence Master (SM)') will increase the number of words learnt by children with ASD'. The aim of the pre- and post-tests (with reference to the hypothesis) is to determine the number of words learnt using the two computer programs.

Empirical study investigation i tested the words learnt in 5 children with ASD. It forms the basis for the other enquiries to follow (empirical study investigations ii-iv). The other empirical studies discussed below provide other benefits for this investigation.

From the results, the SM computer program was noted to promote more word gain than the FM computer program among the children with ASD for the words learnt using this program. These results were significant, as 3 gains were recorded, whilst only 1 gain was recorded in the FM software. However, this is the first stage of the investigation. The reason for the better performance noted with this software will be explored further in empirical study investigations ii-iv.

The results suggest, at a superficial level, that the SM software is better at supporting the learning of new words in children with ASD, although the more in-depth analysis of the results which will follow in subsequent chapters will provide a clearer indication of this. The pre- and post-tests of the SM program (see section 5.2) indicated that three new words were learnt by three of the children (some children were tested on only two words depending on their willingness to be tested) exposed to the program. The FM program recorded limited word gains, with one participant learning two new words only. The results imply that the FM program promotes the least word gain in children, whilst the SM program promotes more word gain.

The results in the SM support the findings of Colby (1973), Heimann et al. (1995) and Murray's (2001) see chapters 2 and 4. Alcalde et al. (1998), in an investigation evaluating the effectiveness of an interactive multimedia program that teaches shapes, colours and concepts about body position in children with intellectual disabilities, noted a statistically significant difference between the group taught using the software and those who were not. Tjus et al. (1998), in a investigation into the benefits of a strategy that combines a motivating multimedia program and positive interactions with the teacher in children with ASD and various cognitive disabilities, recorded that the children with ASD's reading became more rapid following the intervention. The over-riding problem with these studies was that they focused on the more able ASD children; hence the current research differs from these studies.

The advantage of the pre- and post-tests (which are part of the experiment; see chapter 4) is that they provide an initial indication about which of the two computer programs is more effective in the teaching of new words.

This investigation is limited by the communication tools employed to test the words learnt. Some children with ASD respond to the use of actual objects when learning new words or situations, as noted by Peeters (2001), who suggested that objects should be used as communication tools for teaching and communicating with children with ASD. Using objects may have had some effects on the tests scores. This tool is, however, limiting, as not all words can be replicated by objects and there is the problem of the size and weight of the object. The actions and incidents that arose during the implementation of the tests involved the testing tool that is most appropriate for testing the children’s words (to be taught and those learnt). Varied versions of the words were tried out and the advice of the classroom assistants was solicited to facilitate the selection of the most suitable communication tools for the test.

Another limitation is the methodological problems that may have arise from the fact that the children could have been exposed to other learning opportunities than those provided by the computer programs; for example, they could have learnt the words in class, although this is unlikely, since all of the children, prior to the test, were non-readers.

There was the problem of trying to find the most appropriate seating arrangement for the tests. Careful deliberation was given to this task, as the seating arrangement needs to be comfortable and conductive to the needs of a child with ASD (who may have problems with attention and hyperactivity), as well as effective for the successful implementation of the tests. There were occasions where the seating arrangement had to be adapted to suit the child; for example, the test materials were place on a work-station instead of a table in order to make it more accessible to the children.

The tests were implemented as effectively as possible, given the special condition of the investigation (the venue and access problems) and the special disposition of the participants. Additional researchers could have minimised some of the difficulties encountered while implementing the tests, which involved quick thinking, the experience of ASD and adapting skills.

At this juncture, the advantages and the drawbacks of both the SM and FM computer programs are not apparent, and questions arise, such as: why is the computer program SM more effective in supporting the learning of new words in the children? Further investigation is needed to throw more light on the disparity between the numbers of words learnt in the two computer programs. The following section will investigate further the appropriateness of both computer programs, using the observation (video recording) method.

8.2.2 Empirical Study Investigation ii: User Interaction

The central research question, 'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?' This question motivated three further questions and hypotheses that were tested. These are attention, motivation and engagement in the 'Sentence Master' (SM) and the 'Speaking for Myself' (FM) computer programs.

R.1: Can an educational multimedia computer program sustain the attention of children with ASD?
R.2: Can an educational multimedia computer program motivate children with ASD?
R.3: Can an educational multimedia computer program engage children with ASD?

The hypotheses tested are:
(H1) Looking (sustained attention) will be less when children with ASD use a computer program that contains little or no animation.
(H2) External prompts (computer, physical and verbal prompts combined) will be needed to keep the children with ASD motivated. In essence, the more prompts, the more touching will occur.
(H3) Episodes of boredom and stress (lack of engagement) will be greater when children with ASD use a computer program with high levels of repetition.

Discussion of the results

A summary of the results (SM and FM computer programs) in the context of the three measures (attention, motivation and boredom and stress) indicated that the TD children recorded better levels of attention when using the FM software, with more looking at this computer screen, than was recorded with SM. In the motivational category, the children with ASD recorded a higher degree of touching of the screen in response to a prompt than the TD children. More physical and verbal prompts were noted with the SM computer program. More spontaneous touches were observed with the SM software in children with ASD, while more spontaneous prompting was observed with the FM software in the TD children. In the engagement category (which measures the duration of any stress and boredom in the session coded), the levels of boredom and stress was greater for the ASD children than was the case when using the SM software (see chapter 5).

The observation results reveal pertinent issues which form part of the basis of the suggestions for the framework discussed in section 8.6.2. The results revealed design flaws in both computer programs. Regarding the results for measuring attention, both the ASD and TD children were more attentive when using the FM than the SM software. The implication of these results is that the attention of the ASD and TD children was sustained by the FM computer program and that this program is more effective in encouraging both groups of children to look at the computer screen compared to the SM program. Whether their sustained attention leads to actual words been learnt is a different consideration (see below).

The post-test results (see chapter 4) appear to conflict with the observation results or FM is a piece of poor educational software. The ASD children were recorded to have learnt more words using the SM rather than the FM software, although the observation results show that the children appeared to be more attentive when using the latter. This finding suggests that more is needed to learn new words than merely attention, thereby supporting Moore and Calvert's (2000) study, which recorded that, although computer programs can create an interesting, simulating environment for children with ASD, more is needed for them to learn new words.

Regarding motivation (or touching behaviour), the ASD children recorded higher responses to prompting than the TD children. A detailed analysis of the individual software used by the ASD children revealed that more prompts were present when they used the SM than the FM software. The SM software, that provided periodic verbal prompts (for example, the verbal prompt' Press the key to continue'), more computer prompts were recorded in this software, whilst the SM software recorded no touch in response to the computer prompts. The FM software did not promote motivation in the ASD children who have problems with motivation, as observed by Frith (1989) and Autism Spectrum Australia (2002).

This presence or absence of prompts in the computer programs raises the pertinent question: 'Does the presence or absence of prompting in the software affect learning in ASD children?' The post-test results (see chapter 4) appear to suggest that the presence of verbal and physical prompting may affect the performance of the ASD children when using the SM software, as the ASD children learnt more words in this software. This is consistent with Heimann et al. (I993,1995), who noted that a planned intervention, using computer-instructed learning that included a highly motivating and interactive multimedia environment, will improve the reading, writing and communication skills of children with ASD or mixed handicaps (cerebral palsy or mental retardation).

Investigating the frequency of touching in response to the prompts, as recorded in the results, in the verbal and physical prompts category, it was noted to be relatively higher among the ASD than the TD children. Some of the key questions that came to light during this investigation were: 'Do we need prompt to motivate children with ASD to use ECP?', and 'Is there a need to have teachers and parents moderating the use of the computer program?', as the results in chapter 4 appear to confirm the importance of an adult moderating the learning of the child whilst using ECP (see chapter 5) in the previous section, reinforced by Heimann et al. (1995)).

Some questions that need to be considered include: 'How can we incorporate prompts into the design of computer software for children with ASD?', and 'What kind of prompts, if any, should be employed?' The three prompts (physical, verbal and computer) require further investigation in order to determine which one is more effective.

The frequency of the prompts (and the post-test results; see chapter 4) supports the view that prompting does help to motivate children with ASD, as postulated by Tjus et al. (1998), since an effective multimedia program can help children with ASD to develop their reading skills, when combined with teacher intervention. This was not the case for the TD children, who were unaffected by the presence or absence of prompts.

The results of boredom and stress, which measures the engagement of the children in the ASD children show increased boredom and stress behaviour compared to the TD children. For the ASD children, there were clearly more episodes of boredom and stress when using the SM than the FM software.

The SM computer program produced more episodes of negative behaviour among the ASD than the TD children. The level of boredom and stress present among the children with ASD when using the SM software may be attributed to the high level of repetition employed in it, since there is a direct link between the high levels of repetition present in the software and the negative effects observed, reflecting the frustration of the children with ASD. The implication of this is that, although TD children may be able to tolerate a high level of repetition, children with ASD have a lower tolerance threshold and may display more negative behaviour and self harm when this occurs, thus diminishing their enjoyment of the software (see chapter 5).

It can be inferred therefore that although children with ASD need repetition and structure, the level of repetition needs to be adapted or customised to the child's specific needs. This supports a framework (see section 8.6.2) that advocates the use of adaptive technology as a vital component in designing appropriate computer programs for children with ASD.

In both types of software, relatively fewer episodes of boredom and stress were noted in the TD compared to the ASD children, interestingly, the number of new words learnt when using the SM software suggests that it engaged the children with ASD more effectively. This supports Murray's assertion that computer technology offers children with ASD a positive, reinforced environment and an effective way for them to explore and learn (The National Autistic Society 2008f). Erickson and Staples (1995) also noted the benefits of structure and repetition in the learning and teaching of children with special needs.

It can be inferred from the results that excessive repetition leads to boredom and stress and that this promotes negative behaviour, such as self stimulation, self harm in children with ASD. Trying to determine the borderline or limit of the level of repetition that should be employed in the computer program may be difficult. A prior knowledge of the child will help to indicate this. What will be beneficial is to provide features within the computer program, whereby the teachers and parents of a child can adapt the program to a level that is considered suitable.

These results have proved useful in showing that the SM software is better at supporting users with ASD due to the computer-based prompting and the linear, repetitive features present in the program. Interestingly, when using the FM program, the children with ASD appear to be more attentive, yet, despite this, they learnt fewer words. This implies that, for children with ASD to learn, other considerations besides attention need to be considered, which supports the importance of the current research.
The observation results revealed the pertinent issues which contributed towards the suggestions for the guidelines discussed (section 8.6.2). The results reveal the existence of an essential design flaw in both computer programs. For example, the lack of interactivity (such as animation or prompts) in the FM computer program may account for the lower visual attention in the results, whereas the 2 children present at both sessions (ASD children 1 and 2) recorded 100 marks in the visual attention category for the FM software and

145 for the SM (see chapter 5), supporting Stewart (2002) who, in deliberating on the best techniques for facilitating learning in children with ASD, noted the importance of interest (by interactivity) in motivating this group.

Comparing both computer programs and the two groups of children (ASD and TD)
Is the result of the observation empirical study influenced by the types of software employed in this investigation?

The FM computer program is an educational program which combines the use of audio, video and animation paraphernalia. The features of the program include talking stories, flash cards of everyday words, nursery rhymes, and the sorting of matching numbers and shapes. The navigation of the computer screen is done by clicking buttons on the interface. No audio prompt is given in this computer program at appropriate times. It is not interactive, and repetition occurs (see chapter 1).

The SM computer program is a linguistic-based reading program that combines multimedia technology (interactivity and animated rewards) and printing resources. It is targeted at pupils with problems with developing and mastering reading. It is based on the over learning of words (the repeated learning of words; 40 to 50 trials per word).

The difference between the two computer programs may account for the higher attention paid to the FM among the TD children. For the ASD children (in the findings for the two children who were present at both computer program tests; see chapter 4), it was observed that there was more looking at the SM program. The pre- and post-test results indicated that more words were learnt when using the SM software. Supporting Moore and Calvert's (2000) investigation, the 14 children recorded a score of 62% in the attention and 57% in the motivation categories measured in the CAI, supporting their claim that a computer program can create an interesting, simulating environment for children with ASD. However, the environment must be interesting and simulating, which was not the case with the FM computer program.

Why did both the ASD children observed look at the SM more than the FM? Could it be the interactivity provided by this program? In the subsequent empirical studies (iii and iv), this possibility was investigated further.

Engagement, in the context of this investigation, is defined as an absence of stress and boredom behaviour; for example, the flapping of hands, the making of loud noises or vocalising a complaint. The results from the video recording analysis reveal that the ASD children showed a higher degree of boredom and stress behaviour when using the SM software than when using the FM. The results showed (in the 2 children present for both computer programs) that child 1 recorded 37% vocalisation, 29% hand movement and 14% unspecified negative behaviour. Child 2 recorded 13% vocalisation, 18% hand movement and 5% unspecified negative behaviour. This phenomenon observed could be attributed to the presence of a high degree of repetition in the SM computer program, as suggested by Johnson et al. (2007), who noted that stereotypical or repetitive behaviour, such as hand flapping, may be attributed to this condition or may be a sign of distress, although no direct evidence was presented by these authors.

In the design standards, discussed later in this chapter (see section 8.6.2), it is recommended that the levels of repetition in the computer program should be regularised using adaptive features, which should be incorporated into the program (to be coordinated by the teachers and parents of the child).

Responsiveness (motivation) in the context of this research is measured by the child touching the computer screen in response to a prompt or command by the interface or a prompt by a facilitator[1] or the computer program. The results about this measure noted more prompts in children with ASD. High levels of physical and verbal prompting were found with the SM and lower ones with the FM computer program (see chapter 5), indicating that verbal and physical prompting is crucial for motivating children with ASD to use the computer program, as it was noticed that, the more prompts presented, the more the ASD children were motivated to use the computer program.

In the case of the TD children, less prompting was witnessed, and what was observed was more spontaneous touching with the FM program and computer prompts with the SM program. High levels of computer prompting were present with the SM computer program (which had prompting incorporated within it).

The significance of this finding is that, whilst the children with ASD needed to be motivated to use the computer program, the TD children did not need this aid.

Another factor that appears to affect motivation in children with ASD was the presence of a reward in the SM computer program. The SM software is linear, including prompting and repetition, and it includes animation as a reward when the child gets an answer right (see chapter 1). The children with ASD appear to be motivated by the reward (and repetition) in this computer program, as supported by the behaviourist approach of reward, propagated by Simpson (2001), whom, in an investigation into the effective practice of Applied Behavioural Analysis (ABA) for children with ASD, noted the importance of reward or reinforcement in motivating children with this condition, although no evidence was provided. Strydom and Plessis (2002) stressed that it is pertinent to have some repetition in learning, although they recommended caution, as the levels of repetition must be relative to the users' learning. This literature employed one child as evidence to support their claim, thus reducing the validity of their claim.

The lack of reward could be attributed to the less touching that occurs when using the FM software (as this program provides no computer prompts or rewards). 'Does the presence or absence of prompting in the software affect learning in ASD children?' The post-test results (see chapter 4) appear to presume that the presence of various forms of prompting (verbal and physical) may affect the performance (the greater number of words learnt) of the ASD children when using the SM software, which compelled this investigation to support the use of verbal prompting in ECP for children with this condition.

[1] The classroom assistant or the IT coordinator acted as facilitators in this study.

The importance of sustaining motivation by including prompting and rewards for children with ASD whilst using a computer program is buttressed by the findings of Tjus et al. (1998), who investigated how advancing reading and language through a multimedia program can help children with ASD to develop reading skills, when combined with teacher intervention. They found that, in the 13 children who participated in this research, the mean scores from the baseline to the follow-up were 3.6 SD 9.1 in contrast to the 2.0 mean and 7.0 SD scores.

However, this was not the case in the TD children (in this research) who, apart from the prompting provided in the SM software, were unaffected by the presence or lack of prompts.

The lack of structure in the FM program appears to affect the children (both the ASD and TD children); the program had no obvious beginning or end, which may account for some of the anxiety that arose in some of the children when using it). The children worked through the computer program using the navigation (hurrying through the pages, using the navigation button as if they were searching for the end of the session) arrows without the need to explore what this program provides. The children with ASD appear to be distressed by the fact that there appears to be no end to or exit from the session, which may be another factor that made some of the TD children ask for the session to end prematurely. The results support the fact, noted by Wing (1996) and Frith (1989), that structure is important to children with ASD. The importance of sustaining motivation in a child with ASD is reflected in the guidelines developed in this study (see appendix H).

Pertinent issues that came to light from the observation study are the importance of a structured interface for children with ASD. The benefits of prompting buttressed the fact that this facility is advisable in the design and selection of an appropriate reading computer program for children with ASD, as motivation is a key factor in promoting learning in this group. The use of some levels of repetitive learning appear to promote learning in children with ASD, but too much repetition leads to boredom and stress, promoting negative behaviour, such as self-stimulation or self-harm in children with ASD, as found in the observation results (see chapter 5).

From these results (see chapter 5), the TD children were more attentive than the ASD children; why is this the case? One explanation is that the TD children do not have attention problems that characterise the ASD condition, as noted by Happe (1999), Wing (1996) and Frith (1989).

Investigating the frequency of touching in response to the prompts, as recorded in the results, in the verbal and physical prompts category, it was noted to be relatively higher among the ASD than the TD children. Some of the key questions that came to light during this investigation were: ‘Do we need prompt to motivate children with ASD to use ECP?’, and ‘Is there a need to have teachers and parents moderating the use of the computer program?’, as the results in chapter 5 appear to confirm the importance of an adult moderating the learning of the child whilst using ECP (see response (motivation) in the previous section, reinforced by Heimann et al. (1995)).

Other questions that need to be considered include: ‘How can we incorporate prompts into the design of computer software for children with ASD?’, and ‘What kind of prompts, if any, should be employed?’ The three prompts (physical, verbal and computer) require further investigation in order to determine which one is more effective.

The frequency of the prompts (and the post-test results; see chapter 5) supports the view that prompting does help to motivate children with ASD, as postulated by Tjus et al. (1998), since an effective multimedia program can help children with ASD to develop their reading skills, when combined with teacher intervention. This was not the case for the TD children, who, apart from the prompting provided in the SM software, were unaffected by the presence or absence of prompts.

The results of boredom and stress, which measures the engagement of the children (boredom and stress in the context of this investigation are determined by the presence of hand movement, flapping, vocalisation and negative effects, such as self harm), in the ASD children show increased boredom and stress behaviour compared to the TD children. For the ASD children, there were clearly more episodes of boredom and stress when using the SM than the FM software. This could be attributed to the highly repetitive, linear design of the SM software. This shows that, although children with ASD need repetition and structure, the level of repetition needs to be adapted or customised to the child’s specific needs. This supports the ECPDS standard proposed (see section 8.6.2, ECPDS 5.1) that advocates the use of adaptive technology as a vital component in designing appropriate computer programs for children with ASD.

Although, in both types of software, relatively fewer episodes of boredom and stress were noted in the TD compared to the ASD children, interestingly, the number of new words learnt when using the SM software suggests that it engaged the children with ASD more effectively. By examining the post-test results, it appears that the ASD children learnt more words when using the SM software. This supports Murray’s assertion that computer technology offers children with ASD a positive, reinforced environment and an effective way for them to explore and learn (The National Autistic Society 2008f). Erickson and Staples (1995) also noted the benefits of structure and repetition in the learning and teaching of children with special needs.

It can be inferred from the results that excessive repetition leads to boredom and stress and that this promotes negative behaviour, such as self stimulation, self harm in children with ASD. Trying to determine the borderline or limit of the level of repetition that should be employed in the computer program may be difficult. A prior knowledge of the child will help to indicate this. What will be beneficial is to provide features within the computer program, whereby the teachers and parents of a child can adapt the program to a level that is considered suitable.

In the boredom and stress category, the SM computer program produced more episodes of negative behaviour among the ASD than the TD children. The level of boredom and stress present among the children with ASD when using the SM software may be attributed to the high level of repetition employed in it, since there is a direct link between the high levels of repetition present in the software and the negative effects observed, reflecting the frustration of the children with ASD. The implication of this is that, although TD children may be able to tolerate a high level of repetition, children with ASD have a lower tolerance threshold and may display more negative behaviour and self harm when this occurs, thus diminishing their enjoyment of the software (see chapter 5).

Empirical study ii results have proved useful in showing that the SM software is better at supporting users with ASD due to the computer-based prompting and the linear, repetitive features present in the program. Interestingly, when using the FM program, the children with ASD appear to be more attentive, yet, despite this, they learnt fewer words. This implies that, for children with ASD to learn, other considerations besides attention need to be considered, which supports the importance of the current research. The FM software was less beneficial, according to the test results. The lack of prompting did not promote motivation, especially for the ASD children who have problems with motivation, as observed by Frith (1989) and Autism Spectrum Australia (2002).

Based on the finding regarding the two computer programs (FM and SM), the results with respect to the best method for designing appropriate computer programs for children with ASD (for the three measures of attention, engagement and motivation) lead to some important conclusions: firstly, that attention in children with ASD can be supported by interactivity in the computer program, as supported by the National Autistic Society (2008f) literature on computing for ASD children; secondly, prompting is necessary to motivate children with ASD; and, thirdly, a high level of repetition may lead to boredom and stress in children with ASD.

The observation study results highlight some pertinent issues in the selection (section 8.6.1) and standardisation of computer programs for ASD users (section 8.6.2). Some of these guides include; prompting in computer programs is advisable in the design and selection of an appropriate reading computer program for children with ASD (as motivation is a key factor in promoting learning in ASD children). The use of some levels of repetitive learning appear to promote learning in children with ASD, but too much repetition leads to boredom and stress, promoting negative behaviour, such as self-stimulation and self-harm in children with ASD.

Discoveries were made through observing both groups of children interacting with the computer program. The most striking point is the lack of structure in the FM program and the impact of lengthy repetition on the levels of boredom and stress observed. It appears that both groups of children were more motivated to use the SM program due to the linear structural design employed. At this stage, the evidence to support this is insufficient and further investigation is required to validate this. Sections 8.2.3 and 8.2.4 will explore this area in greater depth. The findings of empirical study ii forms the basis of guidelines numbers 4, 5, 6,7,8,10,11 and 17 (ECPDS Standard 1), 32, (ECPDS Standard 4) 44, 45, 54, 55, 62 and 65 (ECPDS Standard 5), (see section 8.6.2 and appendices H and R).

8.2.3 Discussion of the Empirical Study Investigation iii (Attitude Questionnaire)

Empirical study iii investigates how to improve educational computer programs to accommodate the needs of users (children) with ASD.

The research questions specific to this empirical study investigation (which was motivated by the tests of the hypotheses) are listed below:

(H1) The computer programs (FM and SM) are functional (easy to use)[2] for children with ASD.

(H2) The content and structure of the computer programs are appropriate for children with ASD.

(H3) The computer programs (FM and SM) support the learning style of ASD.

(H4) The computer programs (employed in this study) will promote a positive user experience[3] in children with ASD.

The questions asked in the attitudes questionnaire covered the issues based on the program's functional requirements, the interface (design considerations), the terminology and system information provided in the programs, the navigational issues, attention and motivation, the programs appropriateness for developing reading skills (learning new words) and the subjects' (children with ASD who took part in the study) reaction to the programs.

The results of the investigation into the attitudes of the participants indicate (in the context of the total scores) that the FM computer program is preferred to the SM program. The examination of the results in a general sense (in the light of the two computer programs) shows an obvious preference for the FM from the overall scores (69 and 62: 69 scores in total in the TAs and 62 in the HCs groups). On closer examination of the scores in the four categories employed (usability, content and structure, learning style and positive user experience), different interpretations of the results begin to emerge. In the usability category, for example, the FM program had more positive scores (28 and 26: 28 scores in total for the TAs and 26 for the HCs groups). Regarding content and structure, the SM program had more positive scores (13 and 10), while, in the learning style category, the FM had more positive scores (16 and 11). In the positive user experience category, there was nothing of significance to report.

The results, contrary to the lack of theory regarding the formulation of the FM software from the three hypotheses tested, show a preference for the FM compared to the SM program. The results for the four categories investigated (usability, content and structure, learning style and positive user experience) indicate that, in the usability category, the FM program had more positive scores. In the content and structure, the SM

[2] Functional means that the computer program should be easy to use and learn by the users, who, in the context of this study, are children with autism.

[3] A positive user experience in the context of this study means that the users' have enjoyable encounters or experiences whilst using the computer program.

program had more positive scores, while, in the learning style category, the FM computer program had more positive scores. In the positive user experience category, there was nothing of significance to report.

In the context of the hypotheses tested, in hypothesis one (H1), the computer program is functional (easy to use) in FM. In hypothesis two (H2), the content and structure of SM is more suited to ASD children. In hypothesis (H3), the learning style is best in SM. In hypothesis four (H4), the SM computer program is preferred.

According to the summary of the results for the three levels of data analysed, revealed in level 1 (which summarised the results), more positive attitudes were found for the SM computer program. The TAs' attitude towards this computer program recorded the highest score. The level 2 results (which details the results in four categories; usability, content and structure, learning style and general) indicate that, for the usability questions, the TA2 and HC2 gave positive responses to the questions asked. In the content and structure, both TAs recorded that they favoured the programs, whilst HC2 did not, in the learning style and general categories. The level 3 results (which discussed the agreement and disagreement between the TAs and HCs' attitudes, as well as the differences in their levels of agreement) recorded agreements and disagreements about both computer programs. The results revealed inter-group similarities and disparities between the TAs and HCs' groups.

The implication of these results is that the FM program has features that give it some potency with regard to its functionality and the features it employs. What was the reason behind the preference for the FM computer by the HCs? Could it lie in its varied multimedia tools, such as video, text, sound and graphics? The interview results may help to throw more light on this, as will be discussed in a subsequent section.

Reviewing the attitude questionnaire results in relation to the hypothesis tested in the four categories (see table 8.1) revealed that, for hypothesis one (H1), the program FM is more functional (easy to use), thus affirming the hypothesis. In the second hypothesis (H2), the SM content and structure is more suited for autistic users than the FM. The third hypothesis (H3) does computer programs support the learning style of children with ASD, this was affirmed in the SM program, suggesting the superiority of the SM over the FM software. The fourth hypothesis (H4) tested whether the computer program will promote a positive user experience (enjoyable) in children with ASD and affirmed the use of the SM program. In the context of the four hypotheses, the SM computer program is preferred.

TABLE 8.1 SUMMARIES OF THE RESULTS WITHIN THE CONTEXT OF THE HYPOTHESES

HYPOTHESIS	FM	SM
H1 (Usability)	Affirmative[4]	Negative[6]
H2 (Content and structure)	Negative	Affirmative
H3 (Learning style)	Negative	Affirmative
H4 (User experience)	Negative	Affirmative

A summary of the results in the three levels of data analysed, discussed in three levels (see previous sections), revealed in level 1 (which summarised the results) more positive attitudes towards the SM program than the FM one, with the TAs' attitudes recording higher scores than those of the HCs.

The implication of these results is that the TAs did find some aspects of the computer programs favourable, the reasons for which are explained in the interview results in the next section.

Level 2 analyses the results (which details the results in four categories; usability, content and structure, learning style and general), revealing that, with regard to usability, the TAs had a more positive disposition towards both computer programs. In the content and structure questions, both the TAs and one HC recorded a positive attitude towards the SM program but not the FM. In the learning style category, TA2 and HC1 favoured the FM program, whilst TA1, TA2 and HC1 preferred the SM. In the general questions category, only TA2 recorded positive scores for both programs.

The implication of these results is that the SM was favoured in all but one category by both groups of professionals, indicating that it is judged to be better than the FM program. The motivation behind the preference for the FM computer program by the HCs could lie in the varied multimedia tools, such as video, text, sound and graphics. Why did the TAs appear to have no preference? The interview results may help to throw more light on this.

In the level 3 results (which discussed the agreements and disagreements between the TAs and HCs' attitudes), the TAs recorded an agreement between their attitudes in all categories but one (in the structure and content category with the SM program); whilst the HCs recorded one agreement about the SM and two

---

[4] Affirmative in the context of this table represents a positive score.

[6] Negative in the context of this table represents a negative score

about the FM (see tables 6.28 and 6.29). Equally significant are the different levels of agreement found in the attitudes of the TAs and HCs. In tables 6.28 and 6.29 (see appendix O), the TAs agree that FM is functional (easy to use); however, they differ in their level of agreement. Whilst TA1's response was more affirmative or positive, TA2's response was less so; for example, table 6.23 illustrates scores (see the results section in appendix O) of 4 for TA1 (four is the highest positive score, whilst 3 is a less positive score) and 3 for TA2. Similarly, the same pattern of scoring was noted in the SM condition, where the participants recorded a similar pattern in the attitudes scores as was noted in the FM condition.

The implication of these results is that the HCs show less agreement in their positive disposition towards the computer programs, indicating that both computer programs were lacking in the four categories in which that were investigated, supporting the view of Heimann et al. (1995), who noted that the design of computer programs for children with ASD remains unexplored. The details of these attitudes are discussed above in the results section.

It is interesting to examine the level of disagreement found in individual groups, and across the two groups in the attitude scores. Regarding the total scores (of disagreement) in the TA group, the FM recorded less disagreement than the SM (SM had 7 disagreements while the FM had 5), whilst, in the HC group, there was more disagreement in the FM (8 disagreements) than the SM program (1 disagreement). Some of these differences in attitude relate to issues of navigation (see table 6.19 in appendix O), for the TAs the disagreement was in the area of, structure and features. For example, TA2's attitude score favoured SM as 'usable', and structured for typical ASD children, whilst TA1 did not (see table 6.21 in appendix O). Other significant disagreements noted relate to functionality and whether the programs sustained the attention of an ASD child.

The results for the four categories measured (content and usability, structure, learning style for ASD and positive user experience) indicate, in the usability category, for the TAs (in the FM program), three positive agreement scores out of twelve, (three out of the twelve attitude questions asked). In the SM computer program, the positive agreement found was one out of the twelve questions (one positive response out of the twelve questions asked). In the HCs group, the positive agreement found about the FM program was two out of the twelve questions (two positive response from the twelve questions asked), and for the SM program one positive agreement found about the twelve questions asked. It can be inferred from these positive agreement scores that, although the FM program was preferred by the HCs and the TAs, there was no obvious combined preference in this category, as the scores for both groups were limited. Why were the scores in the positive category so small? Was the software difficult to navigate or was it a structural problem? The empirical study discussed in the next session will throw some light on these issues.

In the content and structure category, the TAs had a positive agreement of four out of four attitude questions asked for the FM computer program, whilst, in the SM program, the agreement found was three out of four attitude questions asked, implying that the FM program was preferred in this category. In the HCs group, regarding the FM computer program, there was no positive agreement but instead, interestingly, two negative agreements out of four questions asked. In the SM program, two positive agreements out of four were found. By implication, the TAs had combined positive attitudes towards the FM and the HCs towards the SM program.

The implication is that, in the individual category scores, the TAs preferred the FM, in the positive agreement category. For the HCs, in the individual category, the SM was less liked than the FM. In the positive agreement (in both HCs) score category, the SM was preferred. By implication, in the content and structure category, the two groups prefer the other computer program; therefore, there was no clear preference.

In the learning style category, the TAs recorded two positive agreements each, out of the seven questions asked, and one negative agreement were recorded for both the SM and FM programs out of seven questions asked. For the HCs group, the FM computer program recorded two positive agreements out of the seven questions asked, although, in the SM program, no agreement was found. It can be inferred from the results that the FM was preferred by the TAs (in the individual category). In the general category, one positive agreement was found in both the FM and SM computer programs among the TAs and no positive agreement was found among the HCs.

The significance of the TAs' attitude reflected aspects of animation which both the TAs noted was absent in the FM program and insufficient in the SM computer program (see chapter 6).

The attitude questionnaires have been useful in determining which of the two computer programs evaluated is preferred by all participants and in what area (of the four categories investigated). In the context of the four hypotheses, the SM computer program is preferred, although the FM was found to be easer to use (usability). In terms of the differences and similarities between the two programs, the HCs in terms of usability preferred FM for content and structure, while the TAs had combined positive (favourable) attitudes towards the FM and the HCs towards the SM computer. In terms of learning style, the FM program was preferred by the TAs. In the general category, no preference was found among either the TAs or HCs.

The benefits of the parameters measured in this investigation were the 3 levels, which are subdivided into sub-measures (see table 6.1 in chapter 6). The parameters were considered useful in providing more detailed analyses of the questionnaires results. For example, in the level 3 parameter, the agreements in attitudes across both groups of participants were measured, thereby giving the across-group agreements and disagreements. The benefit of this analysis is that a picture of the similar attitudes in favour or against both computer programs measured came to light. This assisted in buttressing the pertinent issues in the computer program.

The attitude questionnaires were valuable in determining which of the two computer programs evaluated are preferred by all participants and in what area (of the four categories investigated). Within the context of the four hypotheses, the SM computer program is better (preferred), although the FM was found to be easer to use (higher usability). In terms of the differences and similarities between the two groups, the HCs, with regard to usability, preferred the FM, for its content and structure, while the TAs had combined positive attitudes towards the FM and the HCs towards the SM computer programs. In terms of learning style, the FM was preferred by the TAs. In the general category, no preference was found among either the TAs or the HCs.

The attitude questionnaires were designed to incorporate the ideology of the Heuristics evaluation method (Nielsen, 1994) and the Rare Event theory (REL; Nelson and Tjus, 1997, Nelson et al, 2001). Heuristic evaluation and the Human method is an off-the-shelf discount usability evaluation method (Molich and Nielsen, 1990; Nielsen and Mack, 1994). Rare Event Theory (REL) aims to improve learning opportunities for children with ASD and learning difficulties, advocating what is called a "Tricky mix" (combination) of conditions (see chapter 3).

Software that incorporated the theory into the design of reading software is the Alpha software by Heimann et al. (1995) which based it design on the REL model (see chapter 3). This theory impacted on the design in terms of its attempts to facilitate learning opportunities for children by providing the essential element that will stimulate learning. This theory is partitioned into five conditions (known as LEARN: the launching, enhancing, adjustment and readiness conditions).

The benefits of the REL model (theory) include the fact that it focuses on consolidating the conditions under which learning is achieved by providing the structure needed for learning and consolidating what has been learnt. This theory, when applied, could provide the support needed for slow, moderate and rapid learners, by pacing the way in which children learn according to their needs and abilities.

The limitations noted include the lack of ASD preferences and characteristics in the model (see the ASD theories in chapter 3); for example, in the launching condition, emphasis is placed on the children retaining the information learnt in their working memory, which, in children with ASD, who depend on rote learning, is problematic, and will limit the child from successfully employing the software.

The need for a theoretical basis for the software, as in the case of the SM software, can be found in another program with a theoretical failing (or a lack of it). The FM computer program lacks the fundamental theoretical basis, as found in the SM program. Although the architecture and overall ideology behind the software appear to be fair The effect of a lack of any theoretical formulation to support the design of a program for children with disabilities, such as ASD, becomes apparent in the failure to apply the appropriate theory to guide the design of the program, reducing the benefit of this program for children who may otherwise benefit from it.

There is a lack of technical questions regarding how the computer programs bridge the gap between what can be accomplished in term of the learning needs of children with ASD and what can be accomplished via the use of computing technology. A number of aspects could have been implemented differently, beginning with the structure to the depth of the questions asked.

The findings of the attitude questionnaire (empirical study iii) forms the basis of guidelines number 6, 7,8,15 (ECPDS Standard 1) and guidelines number 34,36,37,38,40,41,42 (ECPDS Standard 5; see section 8.6.2 and appendices H and R).

8.2.4 Empirical Study iv: Eliciting Opinions (Interviews)

The main research inquiry (as noted in previous sections) is to investigate the question; 'What is the best approach to designing appropriate educational multimedia computer programs aimed at advancing early reading skills (word acquisition) in 5-10 years old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?'

This question (as in the other empirical studies) motivated the enquiry;
R1:'How can Educational Computer programs (ECP) be improved to support learning to read in children with Autistic Spectrum Disorder (ASD); with reference to the two ECP ('Speaking for Myself' and 'Sentence Master') investigated?'

The aim of the interviews is to throw light on the professionals' opinion about the appropriateness of the computer programs employed in the study. The interview is one of several data collection tools (discussed in previous chapters), aimed at evaluating the FM and SM educational computer programs.

Interviews I and II Results

From the two interview results (shown in interviews I & II), the notable improvement that is needed for both computer programs evaluated in this study comes to light.

The findings from the interviews emphasize some of the key issues which need to be addressed in the design of appropriate educational computer programs for children with ASD. Pertinent issues that hinder the users (children with ASD) from fully benefiting from the computer programs and suggestions were noted. Conducting these interviews enabled the issues (found in the results from the other empirical studies) to be explored in greater depth than would otherwise have been possible.

These interviews results form a crucial aspect of the information gathering process and are employed in developing a set of guidelines to facilitate the design of appropriate computer programs for children with ASD.

From the results recorded notable features were noted in both computer programs. With the FM computer program, the use of varied communication tools was recommended by the participants in the first interview and noted as being important in the second interview. In this study, and in most cases with children with ASD (at the severe end of the spectrum), most of these children are non-verbal (with delayed language development; or where speech is present it may be repetitive and idiosyncratic, as noted by Hetzroni and Tannous (2004)). It is not used effectively to communicate via the use of flash cards and symbols, and, likewise, the communication tools employed in learning and communication in children with ASD were also commended.

Some limitations noted in the computer program include the fact that the FM computer program had no instruction or prompting about what the child should do. As children with ASD need to be prompted, this program is inappropriate in this context.

In the SM computer program, the images used within the computer program did not correspond to the word taught. For example, the word ‘bus’ was taught by a man wiping the windows to reveal the word, which may be misleading to a child with ASD. Since children with ASD suffer from generalisation problems, they may have problems transferring their knowledge of the word ‘bus’ to the physical representation of the word, as noted by Baron-Cohen et al. (1985) and Siegel (2003). Another notable area in which both computer programs were inappropriate is in their failure to apply the autistic style of learning to the interface design.

Another problem noted was the lack of motivation, which is one of the main challenges in ASD. The SM software, as noted by the TAs (in interview I) and the communication assistant (in interview II), will increase the amount of time that an ASD child spends on the computer program and may promote a positive user experience, as noted by Eisele (1980), who stated that feedback is necessary to reinforce and encourage the desired response.

Attention is another aspect of ALS that should be employed in ECP for children with ASD. Interviews I & II note that there is the need to attract and retain the attention of the ASD child when using a computer program. The use of bright colours in the interface is one way in which this can be achieved; this was noted in both sets of interviews. This is supported by Goulden (1998), who noted that empirical studies show that children with ASD respond better to bright colours. Neither of the two computer programs evaluated employed bright colours (especially in the text).

The use of rewards is another way to motivate children with ASD. This was noticed in the ASD children in the observation investigation (see chapter 5), but children with ASD have problems staying on track and need to be encouraged. The use of rewards is one way in which this can be achieved, as noted by both TAs in interview I. The FM offers no obvious reward but the SM program does, although both TAs felt that it was limited and that more is needed to motivate the child to stay on track whilst using the computer program.

Similarities between the results of the two sets of interviews were found with regard to interactivity, adaptability and aesthetics. In the interactivity condition, the TAs and the HCs noted the lack of interactivity in the FM computer program. The lack of interactivity was noted as well by the ASD professional (interview II) in both groups, who claimed that it would help to sustain and maintain attention in children with ASD. Both sets of interviews noted the need for adaptability in the computer program; this view was stressed by the TAs and ASD professionals. The aesthetics aspect was noted to be wanting. There should be a limited amount of information and images in the computer programs’ design for ASD children.

There were certain issues that were noted by the TAs and not discussed by the HCs, such as the need for the computer programs to be adaptable so that they can meet the specific needs of each child with ASD. This factor is pertinent, since ASD is a spectrum whereby no two children are the same but all children with ASD share the same characteristics.

A pertinent issue noted by the TAs is the need for computer programs designed for children with ASD to have what is known in this investigation as the ‘Autistic Learning Style’ (ALS). ALS is a term employed to describe the special way in which children with ASD learn which is based on the characteristics of this condition (see chapter 1 for more details).

Interactivity in the computer program design was not mentioned in the interviews with the ASD professionals but was noted as pertinent in the second set of interviews.

This could be due to the fact that the second set of interviews was mainly prescriptive and not based on empirical experience (actual use of a product), as in the other set of interviews.

The ASD professionals recommended the use of cartoon figures and technology that will support the children's drawing and writing whilst learning to read.

The participants in interview II did not interact with the computer programs, but the interview was prescriptive (based on the interviewees' recommendations) rather than descriptive. This may account for the less detailed recommendations provided during these interviews. The venue for the TAs' interviews was noisy, which sometimes made the transcription difficult.

In summary, there is a need to develop software that is appropriate for children with ASD, as noted by Moore et al (2001) who suggested that computer-aided learning for children with ASD remains unexplored. From the interview results, the general consensus among all of the ASD professionals is to make all the styles of learning for ASD available in the one computer program. One way to achieve this is to develop adaptive features in the computer programs, whereby all of the essential learning tools for ASD can be merge and deployed when the teachers or parents think that this is necessary, as they know the child best. Features such as animation, font, size, colour and type will be incorporated into the program and adapted to suit the needs of the child.

The way forward is to employ the aspects of these two computer programs and to discard any features that do not support children with ASD using the computer programs effectively. A set of standards with these 'good features' was developed. These standards forms the design guidelines listed in appendix H (this is discussed in section 8.6.2).

Discussion

The key issue that the interview aims to address is the appropriateness of the computer programs in supporting early reading skills in children with ASD. In addition to this, the features of the computer program that were considered problematic, such as the lack of prompting, interactivity and rewards, were also examined. In the SM computer program, the problems noted included the lack of a communication tool for ASD, and excessive repetition.

Some of the limitations noted with the FM computer program were that it lacked instructions or prompting regarding what the child should do. Children with ASD need to be guided whilst using a computer program, as they may lack the initiative to know what to do, as noted in the LD Online Newsletter (2006), which stated that, since ECP permits children to direct the flow of the interaction through text and other elements of these programs, children with learning disabilities cannot fully benefit from such ventures, as they lack the strategies required in order successfully to negotiate this type of program.

A problem noted with both computer programs is the lack of repetition in the FM and the use of excessive repetition in the SM computer program. Strydom and Plessis (2002) noted the importance of repetition in sustaining learning, indicating that the level of repetition may be linked to the levels of words learnt in chapters 4 and 5.

Although repetition is important in learning, high levels of repetition may lead to a failure to learn. Bartoli (1989) noted that repetition is unproductive and a sign that learning is not taking place. As witnessed in this study, there were high levels of boredom and stress observed in the ASD children (empirical study investigation ii, see chapter 5). There is a need, therefore, to regulate the levels of repetition in the SM computer program. A border has to be drawn for each child in order to limit the degree of repetition to which s/he is exposed.

The implication of this is that, although TD children may be able to tolerate a high level of repetition (especially if the experience is not enjoyable for the child), children with ASD have a lower tolerance threshold and may display more negative behaviour (as they are noted to be hyperactive, as cited by Aman (2004)) and engage in self harm (as noted Edelson (b) 2008) when this occurs, thus diminishing the benefits of the software. As indicated in the guidelines (see appendix H), the prior knowledge of the child should give some indication to the teachers and parents or guardians about the appropriate level to apply.

A further problem noted in the software was the lack of motivation (motivation in the context of empirical study investigation ii); the observation study, is determined by the presence of the touch behaviour as a result of prompting to use the FM program). Stewart (2002) noted the problem of motivation in children with ASD, stressing the need for any teaching and learning conducted with this group to address these problems. It is, therefore, vital in the design of ECP for children that the system should be sufficiently robust to accommodate the needs (employing prompting based on the child's interest and skill can facilitate this, as noted in the observation results; see chapter 5) of the child; by so doing, the child will be motivated to use the program. This implies that prompting is essential for sustaining motivation. The implication of this, found in the context of employing the ECP guidelines advocated in this study (see below), is that prompting should be incorporated into a program for ASD children in order to promote interaction.

In the SM program, a lack of communication tools was noted by the participants in both sets of interviews, as the children with severe ASD are mostly non-verbal and the appropriate communication tools were needed to teach and aid their communication. Also, these tools should be at an appropriate level of communication and develop the child, as noted by Peteer (2001), who stresses the importance of using appropriate communication tools for children with ASD.

The implication of this finding is that children with ASD will benefit from having appropriate communication tools in ECP targeted at ASD children. The guidelines proposed on the basis of this finding recommend that appropriate communication tools (listed in appendix h) should be included in the design of an appropriate computer program for children with ASD.

An additional problem noted in the SM software is the use of inappropriate and confusing images in the software. The images employed in the computer program to teach words did not correspond to the word taught. For example, the word 'bus' was taught by an animated image of a man wiping the windows to reveal the word ('Bus'); this may be misleading to a child with ASD, who has generalisation and inference problems (see chapter 1).The child will experience two likely difficulties; firstly, s/he may have a problem of association as s/he will be unable to relate the word 'Bus' to the physical image of a bus. The child will likewise have problems transferring his/her knowledge of the word 'Bus' which s/he may think is associated with cleaning a window (as depicted in the SM program) to the physical image of a bus (in a real life situation).

The implication of the confusing image representation, discussed in the interview results (see chapter 7), is the recommendation in the guidelines that (see appendix H), in order to facilitate learning in children with ASD, the appropriate use of images and graphics should be applied, in other to alleviate the learning problems of children with ASD, who experience problems with inference and generalisation (as noted by Wing (1996), Powell and Jordan, 1997 and Powell 2000), so designing a computer program with such a fault (as noted in the SM) will hinder the learning of these children.

The use of rewards using animated images is another way to keep children with ASD interested. Moore and Calvert (2000) noted that interesting sounds and object movement can keep children with ASD motivated, as was observed in the SM computer program from the observational study investigation of this research, which recorded computer prompting in the ASD children 1 and 2, who participated in both computer programs. A significant increase in motivation in child 1 $P<.001$ and child 2 recorded significance levels of $p<.002$ in the SM compared to the FM software (see chapter 5), but children with ASD have problems staying on track and need more encouragement with the FM software. The use of rewards is one way in which this can be achieved, as noted by both of the TAs in interview I. The FM offers no obvious reward but the SM program offers some, although both TAs felt that this was limited and that more is needed to keep the child interested and on track whilst using the computer program.

Similarities between the results of the two sets of interviews were found with regard to interactivity, adaptability and aesthetics. In the interactivity condition, the TAs and HCs noted the lack of interactivity in the FM computer program. The lack of interactivity was noted as well by the ASD professional (interview II) in both groups, who claimed that interactivity would help to sustain and maintain attention in children with ASD. For the adaptability aspect, both sets of interviews noted the need for adaptability in the computer program; this view was stressed by the TAs and ASD professionals. The aesthetics aspect was found wanting. There should be a limited amount of information and images in the computer programs' design for ASD children.

There were particular issues that were noted by the TAs and not discussed by the HCs, such as the need for the computer programs to be adaptable so that they can meet the specific needs of each child with ASD. This factor is pertinent, since ASD is a spectrum where no two children are the same but may share the same characteristics.

The participants in interview II did not interact with the computer programs, but the interview was prescriptive (based on the interviewees' recommendations) rather than descriptive. This may account for the less detailed recommendations obtained during these interviews. The venue for the TAs' interviews was noisy, which made the transcription of the interviews difficult at times.

The way forward proposed by this research is to employ the aspects of these two computer programs and to discard any features that do not support children with ASD using the computer programs effectively. The next section will compare the results of the four empirical studies and make recommendations. These recommendations will form the guidelines for designing good computer programs for ASD children, and listed in appendix H are the guidelines for designing appropriate computer programs for children with ASD.

Overall, the general findings from the interviews were potent in stressing the need to employ ASD-style features that will accommodate the needs of ASD children and the need to modify or discard features that do not support the child's learning. These findings, along with the other findings about the core of the design guidelines, will be discussed in the subsequent sections.

The findings from the interviews is reflected in guidelines number 6,7-10,11-16 (ECPDS Standard 1), 18,19,20-24 (ECPDS Standard 2) 25,26,29,30 (ECPDS Standard 4), 43-46,47-62,64-67 (ECPDS Standard 5 ;see section 8.6.2 and appendices H and R).

8.3 Assessment of the Two Computer Programs

In this section, the MURASD researcher's evaluation of the computer programs under investigation is discussed. The researcher's assessment is aimed at determining which of the two reading programs is more appropriate for children with ASD.

The section is divided into two parts. The first part discusses the researcher's evaluation in the context of the four empirical studies employed in this research. The second discusses the assets and deficiencies that the researcher found in both programs. These findings, along with those discussed in previous chapters, form the basis for the guidelines proposed in subsequent sections.

The two computer programs (evaluated to determine if they will promote early reading in children with ASD) were 'Speaking for Myself' (FM) and 'Sentence Master' (SM). The FM program is an educational program, aimed at promoting early language, communication, reading and ICT skills. The area of the curriculum it addresses is reading and communication. The features of the program include talking stories, flash cards containing everyday words, nursery rhymes, and the sorting of matching numbers and shapes (see chapter 1 for more details).

The SM is a linguistic-based reading program that combines multimedia technology and printing resources. It is targeted at pupils with problems with developing and mastering reading The FM and SM computer programs belong to different typologies. The SM program employs the learn-and-drill technique (see chapter 1 for more details).

The researcher's assessment, based on the research and hypotheses tested in the four empirical studies investigated, is as follows:

With regard to the number of words gained, for the hypothesis tested in empirical study investigation i (see chapter 4), the researcher determined that the SM will promote more word gain than the FM program, for the reasons discussed below.

For empirical study investigation ii (video recording), the research determined that, in the categories of attention, motivation and engagement in the empirical study investigation (video recording; see chapter 5), for the three behaviours measured (attention, motivation and boredom and stress), the ASD children are more attentive to the FM than the SM computer program, due to the varied multimedia tools employed in this software.

For the second empirical study investigation (video recording; see chapter 5), in the researcher's assessment of the three behaviours measured (attention, motivation and boredom and stress), the ASD children should be more attentive in the FM condition, as this program combined the use of multimedia which included audio and video (a person signing the words taught by the program). The test results indicate that the children with ASD learnt more words (see chapter 4); however, the observation results (see chapter 5) for the two children present for both computer program tests (the pre- and post-tests) show that a greater percentage of looking was achieved in the SM computer program.

In terms of prompting (motivation) behaviour, the researcher's assessment is that the SM motivated children with ASD more than the FM computer program. In the researcher's view, this is due to the prompting which is present in the program. From the observation results, more prompting was noted in the SM software in ASD children, indicating that prompting supported motivation in children with ASD, who are noted to have problems with attention due to hyperactivity, as noted by Siegel (2003).

The important of motivation in learning was argued by Lee et al. (2004), who noted the benefits of employing computer programs in the classroom. This buttresses the researcher's evaluation of the benefits of prompts and rewards in the software.

Both computer programs may produce episodes of boredom and stress, which may occur on a more regular basis in the SM computer program due to its excessive use of repetition (40-50 trials per word taught), whilst the FM program may also lead to some episodes of boredom and stress, due to its lack of a defined structure (especially its lack of an obvious beginning and end). From the results (see chapter 5), the children with ASD showed more episodes of boredom and stress when using the SM computer program than the TD children.

In empirical study investigation iii, which is measured in four aspects – content usability, content and structure, the learning style for ASD and positive user experience – the research's assessment of the usability of both programs is that the FM computer program is less intuitive(see chapter 6), as it difficult to navigate from page to page without some degree of familiarity with the program, whilst the SM computer program is more intuitive, as it responds to the clicking on part of the interface, and the areas outside this limited area did not incur any action.

In terms of content and structure, the researcher determined that the content of the FM computer program is more robust (the content of the software includes the use of flashcards and a video recording of a person signing the words taught, which support communication in children with ASD) and applicable to the day-to-day educational and social skills of children with ASD, but it is the case that the words being learnt in this program are too extensive to help the child to learn new words. In terms of the structure of the program, it is too complex for the child actually to navigate it without constant help.

The SM computer program is less complex in its architecture. Apart from the teacher or adult choosing the initial set-up of the computer for TD children (although this may not be the case with children with ASD), the child can use the program with limited help compared to the FM program. With regard to the content of the program, the words taught are chosen in the SM program from a list of words which are taught in a systematic, gradual process.

The learning style of the FM program is more compatible with the ASD characteristics and learning style in the areas of communication, as communication problems are one of the main difficulties for children with ASD, as argued by Wings (1996), who noted that communication problems is one of the 'triad of impairments'[7] in children with ASD; for example, the use of a Symbols Picture Exchange Communication System (PECS)[8] and sign language to teach new words, as supported by Bondy and Frost (1994) who noted that the use of visual aids, such as PECS, can support communication in children with ASD.

In this research's assessment, the use of repetition in the SM program is appropriate, as it goes some way towards alleviating some of the information processing problems experienced by children with ASD. Although there has been no direct work on children with ASD, Morris and Fritz (2000) suggested that repetition can improve the memory of unfamiliar names based on the principle of retrieval and practice in an investigation of 265 first year university students. However, only anecdotal evidence was presented to support this claim. This can be applied loosely to children with ASD. Strydom and Plessis (2002), likewise, noted that repetition is essential in supporting learning. However, evidence relating to only one individual was presented to support this investigation.

In respect of a positive user experience, this research found that the FM and SM computer programs, in various ways, do not support a positive user experience for children with ASD, although this was not the case for the TD children (see chapter 6). This may be due to the lack of a clearly defined structure in the program (with no clearly defined beginning or end to the words taught).

Some recommendations for the improvement of the computer programs by the researcher (as discussed in the guidelines proposed in subsequent sections) include:

The application of 'Autistic learning style' in the following aspects:

- Rewards should be included in the program (to encourage the children to use it).
- Prompts should be employed in the programs to motivate the children.
- Animation and other special effects should be employed (to grasp and sustain the children's attention).
- There should be a defined level of repetition to support learning and reduce boredom and stress levels.
- The theory employed in the design should be stated and substantiated.

Similarities can be found between some of these recommendations (see section 8.6.2 and the ECPDS standards in appendix H); however, in contrast with the interviews, the researcher's evaluation is more detailed and prescriptive. The findings of these evaluations are collated and form the basis for the guidelines discussed in subsequent sections.

[7] The 'triad of impairments' are the three main dysfunctions or difficulties of children with autism, which include imagination, communication and social aspects.

[8] The Symbols Picture Exchange Communication System (PECS) is a picture-based augmentative communication method that is commonly employed to support communication in children with ASD.

This research's assessment of both computer programs in the context of which software better supports learning in this investigation finds that both computer programs may, to some degree, support learning. However, both pieces of software have both benefits and limitations.

In the case of the FM program, it is a multimedia-based program which combines effectively audio, video and graphics, whilst the SM computer program employs interactivity; using graphics and animation (whereby the child clicks or touches the computer program interface and obtains a response from the program; for example, the phase 'this is a bus' 'press the key to continue').

One of the key features of both programs that negate the learning style of ASD children is the use of confusing and inappropriate images and photographs. For example, the SM program employed images of a man cleaning some windows when teaching the word 'bus'. As children with ASD have problems with inference, this is not a good option. In the FM programs, some of the photographs were inappropriate for the task of teaching new words to children with ASD. For example to teach the word 'sleeping', a picture of a doll lying down was used. This, as in the case of the SM software (discussed above), may confuse a child with ASD, who has problems drawing inferences, as was noted by Powell and Jordan (1997).

Children with ASD have a problem of 'over-selectivity', whereby they focus on a small amount of information whilst ignoring what may be the central information; for example, focussing on a spot in a photograph rather than the entire picture. In other cases, they may focus on the entirety of a thing; the so-called "chunk style learning", without editing it for relevance, or they may fail to absorb any information at all, simply ignoring everything and focussing on nothing (Autism Spectrum Australia, 2002). The FM computer program is cluttered with too much information.

Many children with ASD are visual learners (Autism Spectrum Australia, 2002), who process visual information more easily than auditory information. Powell (2000) and Powell and Jordan (1997) noted that, every time visual learning is employed in technological devices for ASD children, we are giving them information through their strongest processing area. The use of more visual forms of learning opportunities, such as appropriate images and photographs (which are not cluttered), is required by both the FM and SM programs.

Children with ASD have problems with communication, as noted by Wing (1996) and Frith (1989). Their communication stages (and associated problems) often occur at varied developmental ages, so, in teaching children with autism or designing technology for them, it is important to determine the language age of the target audience in order to be able to develop a computer program at an appropriate level for each user, employing the appropriate method of communication.

Children with ASD have different forms of communication methods which correspond to their levels of development and individual preferences. This could be verbal (the use of words or speech) or non-verbal, which may include communication methods, such as pointing, gesturing, the use of sign language, the use of objects, taking the hands of an adult to show what is desired, the use of the Picture Exchange Communication

System (PECS), the use of Visual Interaction Augmentation (VIA) (Siegel, 2003) or the use of symbols, such as a Widgit.

Rannou (2002) noted that computer programs should support the children for which they are intended, which makes this evaluation the core of this assessment. Although key issues were uncovered during this evaluation, further work is needed to explore the issues discussed in this section. The further work of this investigation will discuss these issues (see the following sections).

8.4 Discussion of the Research Methodology

The underpinning theories employed to investigate the research question, 'Can educational multimedia computer programs advance the early reading skills (word acquisition) of 5-10 year old children with Autistic Spectrum Disorder (ASD) and Severe Learning Disabilities (SLD)?' is based on a combination of theories from various disciplines. These theories are discussed in two categories: the core and the supplementary theories. The core theories, (the main theories) consist of four domains, which encompass Autistic Spectrum Disorder (ASD) learning theories, learning theories (psychology), literacy (education) Human Computer Interaction (HCI) and software engineering, whilst the supplementary theories consist of past (similar) studies (a literature review), and the data collection and findings.

Learning via computer technology is a complex process which involves different strategies, employed by the users depending on their ability, which may include learning through doing, learning by active thinking, learning by setting goals and planning, and learning through analogy, as stipulated by the theories on learning; such as the constructivist, behaviourist and cognitive theorists, as noted in Wall's (2004) review of e-learning.

In conducting this inquiry, it is essential to examine the prevailing theories in the domain investigated which will provide a foundation for the study undertaken and place it in the context of the existing research in that domain, as contended by Cohen et al. (2000) and Robson (2002).

The theories were examined on the basis of the literature and the findings in the studies regarding their suitability for children with ASD; for example, the behaviourist theory by Skinner (Sutherland, 1992), which supports reward as a way to motivate children, and the video recording showed the importance of reward in motivating children with ASD.

Discussed below are the theories that underpin this investigation (their benefits and limitations), beginning with the core theories, followed by the subsequent theories.
The core theories employed in this investigation were ASD theories, learning theories, reading theorises and HCI theorise. The theories on ASD present descriptions, explanations and the characteristics of the condition.

In designing educational computer programs for children with ASD, it is essential to facilitate the principle of a user-centred design by understanding the intended users as, alleged by Preece (1994). This research considered the characteristics of ASD and employing ASD theories (essentially the areas of information processing and behaviour management) in order to understand how to support children with ASD in learning to read through the use of technology.

The main advantage is that these theories provide this Middlesex University investigation with a means of defining and understanding the potential users and determining the best way to support these users using computer technology (this was applied in the evaluation of the two computer programs, with the aim of prescribing the best method for designing computer programs for this populace). Understanding this explanation of ASD affects practice and provides a practical guide to the educational and other interventional strategies for children with ASD, which include the design of ECP, investigated in this inquiry.

The three main theories of ASD applied in this investigation were the weak central coherence, the ‘theory of mind’ and the executive dysfunction theories.

The central coherence theory (which refers to ASD, which specifically relates to the tendency to process incoming information in its context, this may creates rigidity in thinking and perseveration, as postulated by Happe, (1999) provides this Middlesex University investigation with a means of understanding the needs, strengths and weaknesses of the potential users (with regard to information processing) and of determining the best way to support these users through computer technology, applying this theory to the evaluation of the two computer programs, with the aim of prescribing the best method for designing computer programs for this populace.

The executive dysfunction theory explains some of the behavioural problems in ASD which include problems with rigidity (the tendency to be get stuck on a task), preservation (lacking initiative, planning problems) and working memory. Executive dysfunction theories account for some of the social problems in ASD, accounting for problems with planning, memory and imitation to mention just a few, as noted by Hill (2004). This explanation of ASD behaviour affects the design of ECP; which has to take into account this behaviour in other to provide the right atmosphere for children with ASD when using a computer program to learn.

The ‘triad of impairments’ is another theory of ASD that is investigated and employed in this MURASD project; this theory consists of the three key problems related to ASD communication, imagination and socialisation (Wing 1996). The benefit of employing the ‘theory of mind’ is that it throws some light on learning problems in ASD (listed above) which may hinder their use of computer technology and also provides some insights into how these could be minimised using technology (or when a child with ASD uses computer technology).

As discussed above, employing the theories of ASD provides this research with the impetus to understand and prescribe the learning environment that should be put in place in the design of computer programs for children with ASD. These theories (discussed above) provided the needed insights into the learning characteristic as well as the disposition (attention and engagement) and behaviour (hyperactivity and negative affects) of these children; all of these elements are needed in evaluating (and later prescribing) how to guide the design of appropriate computer programs for children with ASD (see chapters 3 and 5).

The limitation of employing the theories of ASD in the investigation of how to design (prior to this, the computer programs were selected) an appropriate computer program for children with ASD is that these theories can be implemented in a vacuum, so more theories are needed to understand the ASD condition (strengths and weaknesses) within the convergence of other crucial opportunities (as was done in this MURASD project), which includes the investigation of related research in other domains (for example, psychology, reading and software design) and through empirical investigation, as implemented in the four empirical studies in this inquiry (see chapters 4 to 7).

The context of the application of the main learning theories employed behaviourism theory and constructivism theory (and cognitive theory, discussed below). The main benefit of employing these theories is that they provide an avenue for exploring the various possibilities to employ; these have to be applied in this investigation in the light of the proposed users (employing the principle of user-centred design; see the following section).

The main limitation of employing theory in system design is the all theories have their own respective strengths and limitations and it is paramount that the system designers are aware of this in order to avoid the loop-holes of each theory and to optimize the theory, as stated by Wall (2004). The benefits of the behaviourism theory approach promotes the mastery of content, as supported by Skinner as noted in Sutherland (1992), as observed in the SM computer program due to the drill-practice and the reward approach employed. It requires less processing capability than the cognitive and constructivism theories.

The constructivism theory strategies were considered for this Middlesex research , but the application of these should be minimal or omitted completely, as they may be too advanced for ASD users (who may have problems with information processing) and they may be ill-equipped to employ ECP at this level, as contended by Wall (2004), who acknowledges that the constructivism theory favoured problem solving in ambiguous circumstances, whilst the cognitive theory advocates observing behavioural patterns in order to understand the minds of the learners.

Arguably, constructivism theory was considered unsuitable for children with ASD due to the lack of structure that it advocates, as in the case of hypermedia technology (an example of constructivist-based programs). It is the conclusion of this investigation, therefore, that children with ASD lack the strategies to use an exploratory program of this nature and so will not benefit from this environment. The theories employed in this investigation impacted on this inquiry in diverse fashions, strengthening the methodology of this research.

The behaviourist theory approach of reward was employed in this investigation, as it was observed in this investigation that children with ASD were motivated to use the SM computer program due to the presence of rewards, as argued by Stewart (2002), who contended that children with ASD will be motivated if their learning style; which involves considering the internal and external incentives for the child to engage in a task, although no evidence was given to substantiate this claim.

The constructivist theory promotes a strategy of teaching problem solving skills which was applied to advanced computer users (which excludes typical ASD children). The limitation of the constructivist theory is that it involves a high level of processing, and children with ASD (who are the proposed users) lack the information processing skills to employ it. Therefore, this theory is recommended at a more advanced level (if it is employed at all).

It is the conclusion of this research that all of the aspects of the behaviourist theories and other theories (discussed below) contain essential elements that should be applied to the design of computer programs for children with ASD.

In the context of the reading theory, the methodological framework of this MURASD project for children with Autistic Spectrum Disorder (MURASD) also explored the appropriate reading theory for teaching reading in ECP for children with ASD. The content and syntax process, the phonological process, the orthographic or whole language or language experience process, the semantic and comprehension process, the traditional method, the look-and say method, the alphabetic method and the phonetic method are commonly used methods in teaching TD children in the public domain.

In the context of application, for this MURASD research, the whole word or orthographic reading approach advocated in this investigation is based on the theory of multimedia learning, as supported by Myer (2001), who advocates employing visual and auditory stimulus in teaching. This MURASD research supports this notion, and advocates that children with ASD will benefit from a learning strategy that capitalises on the fact that it involves visual learning and repetition, as contended by Swenson and Kingman (1981), who argued that repetition of the concepts taught will provide a unique opportunity for the mastery of the concepts. Empirical evidence from the interview conducted with the educationalist in this research (see chapter 7) indicates that the strongest asset of children with ASD is their autistic learning style (see chapter 1). At a later stage, the phonics approach could be gradually introduced as an addition to this strategy (see chapter 3).

Problems with teaching the mainstream reading approach in children with ASD, without adapting it to accommodate their needs, was implemented in this investigation (see the subsequent sections). The depth of the adaptation applied can be criticised for not going far enough into this inquiry. The reading theories (whole language) are applied when combined with ASD theories, learning theories and HCI theories.

The HCI theories was applied to determine the content and architecture of the software, taking into consideration the user (learning style and ability) and what can be achieved using computer technology (in terms of achieving tasks and goals in the context of this research) in the learning of new words using two computer programs as an artefact.

The benefit of applying the HCI principle (a user-centred design, activity theory and MHP) to this investigation is that it provides an understanding of the user characteristics, information processing, early reading and system design (usability) in other to produce usable, effective early reading ECP. Other benefits of HCI in software design is the alleviation of some of the information processing problems in ECP for children with ASD, as well as a predictive model of system design.

Applying HCI theories (user centred design, MHP and activity theory) to ASD theory, learning theory and reading theory (see chapter 3) facilitates the evaluation of appropriate ECP for children with ASD (and the selection instruction) and the ECPDS discussed in subsequent sections. The limitations of applying the HCI theories include the problem of how to apply the trade-off between the user requirements and what can be achieved in the design of computer programs.

The investigation of the appropriate underpinning theories to facilitate this research in a complex venture such as this investigation involves a convergence of various disciplines, ranging from ASD characteristics, dispositions and ASD learning styles (ALS) to learning theories, reading methodologies and system design.

8.5 Discussion of the Research Method

The quantitative and qualitative data collections methods were employed in this investigation to promote the triangulation of the methods. These methods were implemented in four empirical studies which involved four data collection methods; pre- and post-testing (empirical study investigation i), observation (empirical study investigation ii), attitude questionnaires (empirical study investigation iii), interviews (empirical study investigation iv) and Kitchenham et al.'s (2002) guidelines. The latter were employed as a guide to facilitate this investigation; although most of the recommendations in the guidelines were implemented (see chapter 3), some were omitted, as will be discussed at the end of this section.

The main advantage of the pre- and post-test method (employed as the experimental style method) is that it provided a means of measuring the number of words learnt (see section 4.3 in chapter 4). However, there is the methodological problem that the children could have been exposed to other learning opportunities that may have affected the outcome of the testing. As discussed in chapter 4 and section 8.2.1, this is unlikely, since all of the children, prior to the test, were non-readers.

The pre- and post-tests are limited by a lack of additional communication tools to test the words learnt by the children. Some of the children who took part in this research may have responded better if other communication tools had been used; for example, the use of the actual object to test the words learnt, as proposed by Peeters (2001), who suggested that objects should be employed as a teaching and communication tool for children with ASD (see section 4.2, chapter 4). This recommendation is, to some degree, limited, as not all words can be replicated by the actual objects that they represent and there is the problem of the magnitude and weight of the object.

Another constraint noted is that the results of the tests may have been influenced by the exposure to other learning opportunities besides the computer programs; for example, the children could have learnt the words in the classroom or from the television at home. This is unlikely, however, as all of the children, prior to the test, were non-readers.

The implementation of the problems arose during the conducting of the tests (see chapter 4) include: finding a suitable seating arrangement for the children for the tests; this was a challenging due to their disposition (behavioural problems and hyperactivity), careful deliberation was given to this task, as the seating arranged in the tests needed to be comfortable and conductive to the needs of children.

A number of features could have been present in the tests that were not included, including having more testers to facilitate the testing process. The materials for the test could have been expanded to include on-screen testing methods in place of the manual testing procedure employed (see chapter 4).

The problems encountered during the implementation of the tests include the problem of trying to determine the most appropriate communication tool to utilise for the test (as all of the children were non-verbal, a tool by which to communicate the words learnt was needed).

There was the problem with trying to find the most appropriate seating arrangement for the tests. There were occasions where the seating arrangement had to be adapted to suit the child during the process of the test, which was difficult, and care and careful thought were needed to try to prevent disruption to the test processes and procedures.

The venue for the testing could have been designed to have restricted access and less noise. However, as this was the only free room available and the children could be tested in a familiar environment, there was no alternative. A better seating arrangement could have been put in place.

This investigation could have employed better and more communication tools (as all the children were non-verbal), such as the use of a picture of the object (for example to test ‘bus’ a picture of a bus could have been employed) or the physical object itself, where possible. However, given the difficult conditions in which the researcher had to work (outlined in chapter 3), careful planning to minimise these problems was put in place.

The video recording of the children using the computer programs was the next data collection method employed in this research. This method involved recording the children interacting with the computer programs through the aid of two camcorders (one of the cameras recorded the child’s expressions whilst the other recorded the child’s actions on the interface).

This method provided the direct observation of the children interacting with the computer program, providing first hand information about both systems. It provides a direct means of evaluating the two computer programs (and other similar programs developed for children with ASD).

The observation method employed in this research had some limitations. The venue (the computer room in a special school) for the video recording was noisy, with people coming in and out and noise emanating from the corridor outside.

The implementation of the video recording session could have been better organised, especially the hand-held recording by the researcher (the necessity both to record the participants and co-ordinate the sessions hampered the quality of the video recordings, which were sometimes wobbly and distorted). The mounting of the two camcorders did not provide the best view possible of the interface and the children.

The data analysis of the boredom and stress behaviour, and the distinction between the various types of negative behaviour could have been coded individually; this could have provided a more detailed analysis of the behaviour.

The observation method was limited by the fact that there was only one researcher to co-ordinate the sessions as well as manage the two camcorders. Since the time allocated for this session was limited, the researcher could have managed the sessions more effectively if there had been additional researchers present, and the researcher should have negotiated for more time in which to video the participants interacting with the computer programs.

Empirical study investigation iii was completed using the attitude questionnaire data collection method, the rationale for this being to support and provide more details about the evaluation of the computer programs assessed in this investigation (see chapter 6 and section 8.2.3). The benefit of the attitude questionnaire is that it provides an opportunity for the participants to pass judgements on a product, providing an opportunity to determine which of the two computer programs was preferred.

The limitations of the attitude questionnaires are the lack of detail and depth of some of the questions. Further depth was needed for the questions that pertained to the learning style of children with ASD. The content and structure aspect of the attitude questionnaire (see section 6.2.2 in chapter 6), lacked detail. The grouping of the content and structure together, in hindsight, was not a good initiative (as both sets of questions should have been investigated separately). Although pilot studies of the attitude questionnaire were implemented, this problem remained undiscovered until the data were analysed. Since the interviews were conducted after this venture (the attitude questionnaire process), this problem was remedied.

The methods that influenced and were employed in the formation of the attitude questionnaire have their limitations; for example, the heuristic evaluation method (a usability engineering technique), that was employed to determine the usability problems with the computer interface, has its limitations. The heuristic method has been criticised for being simplistic and lacking the depth needed to evaluate a computer program or system, as noted by Sauro (2004) and Cockton and Woolrych (2002).

An adaptation of the Rare Event Learning Model (REL) employed in the formation of parts of the attitude questionnaire is limited. As the researcher encountered problems in adapting this theory to the attitude questions, some of the questions were over simplified and lacked sufficient depth for example question ask regarding the content of the word taught by the computer programs could not be adapted to fix into the five conditions of the REL theory (see section 4.2.1 in chapter 4). Combining different ideologies (Heuristics and the REL theories) may create the additional problems of repetition, the overlapping of ideas and contradictions.

Several aspects of this empirical study investigation could have been completed differently. To begin with, the structure of the questions could have been implemented differently; for example, the structure and content category overlapped with learning style. The questionnaire could have been more detailed and the wording of the questions could have been more concise.

The attitude questionnaire could have been more detailed and more clearly expressed. For example, statements such as 'the program is easy to learn' could have been reworded as 'the computer program can be easy for a child with Autistic Spectrum Disorder to learn to use in a short amount of time'. The user experience of the questionnaire was limited and could have had more depth. For example, questions relating to learning style and the support that the ASD child may need effectively to benefit from using the computer program were not sufficiently discussed. Nonetheless, the attitude questionnaire provided an avenue for obtaining some valuable information on the professionals' judgments of both computer programs, which provided the initial basis for evaluating the computer programs.

The attitude questionnaire questions could have had a different structure. For example, in order to promote the triangulation of the methods and to provide a balanced perspective of the attitudes, this empirical study investigation employed a positive and negative-based questionnaire (see chapter 6). This created some problems with the data analysis and interpretation of the attitude scores, as discussed above.

The fourth empirical study investigation, employing two sets of interviews, was conducted with professionals in education (teaching assistants) and HCI (see chapter 7). The first set of interviews was conducted in conjunction with the attitude questionnaire (section 7.2.1 in chapter 7); the second set was a recommendation and requirement gathering exercise.

The interviews were employed to solicit the views of the professionals on the appropriateness of the computer programs employed in this inquiry (interview I) and also about the best ways to design an appropriate reading program for children with ASD (interview II).

Some of the benefits of employing the interview method include the fact that it provided a clearer understanding of the attitudes noted, as well as giving greater depth (as described by Denzin and Lincoln (1998)) to the attitudes recorded in the empirical study iii investigation. An additional advantage can be found in the prescriptive nature of the second interviews, which provided a focus for obtaining the views of professionals in education regarding their recommendations about what an appropriate computer program for ASD children should provide.

The interview method employed in this investigation is limited in a number of aspects.
The venue for the interviews could have been more conducive.
Since they were held in an educational establishment, in which there was a lot of activity, the noise levels were high and there were many distractions, which affected the quality of the interview recordings, which were sometimes distorted.

Several aspects of the interviews could have been improved; for example, the venue for the interview (for the ASD educationalist) could have been moved to a quieter location, but this was not viable, due to the workload of the ASD educationalist.

The interview questions, in retrospect, were not sufficiently detailed and the level of depth required for the questions was sometimes omitted. Aspects of the questions which would have facilitated a more detailed evaluation of the two computer software programs were not sufficiently explored due to the time constraint.

The second set of interviews (interview II) was prescriptive (based on the interviewees' recommendations) rather than descriptive; as the participants did not interact with the computer program. The danger of a prescriptive recommendation is that it is generic and may lack the detail and specificity of evaluating a specific program. This may account for the reduced number of detailed recommendations made during these interviews (see chapter 7).

The main benefit of the data collection method employed in this investigation is the combination of various qualitative and quantitative data gathering techniques. This promotes rigour and brings clarity to the research findings, providing opportunities to substantiate the reliability and validity of this investigation.

The general problems that arose across the board with all of the data collection methods employed in this investigation include:

- A limited sample size, due to the nature of this inquiry and the difficult of researching children with ASD (due to their ASD characteristics and the disposition of the main participants).
- There was also the issue of access limitations and difficulties in recruiting participants with ASD.
- There were accessibility problems and last-minute cancellations. There were a few occasions when the site had to be adapted at the last minute due to changes in location or the unavailability of the participants at the time. Nevertheless, the researcher was able to adapt quickly to such changes.
- There were difficulties in recruiting participants for the research.
- The children were sometimes volatile and had explosive dispositions, although the researcher's knowledge and experience of ASD proved to be beneficial in dealing with these problems.
- There was limited assistance available to implement this research, which imposed constraints on this investigation; for example, a second researcher could have being employed to operate the second camcorder. However, since this investigation is a PhD research, the funds for recruiting an extra researcher to operate the camcorder were unavailable.

- There was the problem with the implementation of the data collection in the areas of the management and the implementation of the pre- and post-tests as well as the video recording. This affected the data collection; for example, during the video recording sessions, the researcher had to manage one of the camcorders as well as give instructions to the participants about using the computer programs.

- It would have been useful for a second person to operate the second camcorder because it would have improved the quality of the video recording as well as the overall management of the video recording sessions.

- One area in which quick-thinking and resourcefulness was needed was the testing of the children in order to determine the word known before (the pre-test) and after (the post test) the sessions. Some of the methods of testing (tools) that the researcher explored are the use of concrete objects, as well as typed words and symbols. The researcher realised that it is difficult to employ the actual object due to its size and the cognitive problem that this may present to a child with ASD (as it may confuse the child with this disorder who may have generalisation problems); for example, using a toy bus or a model to test the word 'bus' may be confusing for a child with ASD who may not have translated the word 'bus' on the computer screen into the physical representation of a bus.

- Problems arose during the video recording sessions mainly due to the fact that the children were conscious of the researcher's presence and this could affect their performance. Sometimes, the participants (children with ASD) tried to obstruct the video camera. As the researcher had to manage the session and record the participants at the same time, the recording was sometimes obstructed or wobbly. There was also the problem of the time restraint. As the researcher had limited time to conduct the study, there was only one shot of each video recording, and the sessions could not be repeated, which may have lead to the loss of a lot of vital information.

- There was more disruption and difficulties in conducting the interviews and video recording with the teaching assistants and both the ASD and TD children. As the interviews were conducted on school premises (in the case of the ASD children) and a homework club (in the case of the TD children), when the school or homework club was in session, this made the quality of the interview recording poor due to noise and disruption. In the first set of interviews conducted in the schools, the venues, being on school premises, were sometime noisy and disruptive; people kept walking by, as the venue houses a corridor; therefore, concentration was sometime difficult during the interview, and this also created some difficulties when the interviews were transcribed due to the excessive noise, and, in the case of video recordings, it diminished the quality of the recording.

Combining the qualitative and quantitative methods enabled this MURASD project to have a rounded and robust perspective. This promotes rigour and gives clarity to the research findings; for example, triangulating the quantitative data collection method (pre- and post-tests and the video recordings) with the qualitative (interview) method with regard to reward and repetition, in the SM computer program (which the interview with the teaching assistant brought to light) demonstrated how it facilitated learning in children with ASD. This, in turn, gives validity to the post-test results, where it was reported that 3 ASD children gained new words (in the SM program) whilst only one child gained new words in the FM computer program (see chapter 4). Similarly the interview gave clarity to some of the attitudes noticed in the attitude questionnaire; for example, in the attitudes towards the content or features of the computer programs, the attitude questionnaire alone will not give details of the individual content or features of the computer program, nor will it provide recommendations on how it can be improved, as can be obtained from an interview. Therefore, combining these methods and tools provided various opportunities to substantiate the reliability and validity of the data.

Combining the qualitative and quantitative data gathering techniques may be critiqued for “sitting on the fence” and not taking a stringent stand in either direction (the quantitative or the qualitative) and, therefore, lacking credibility. However, this can be counteracted by the response that combining these two techniques facilitates the triangulation of one technique with another, thereby promoting the credibility and validity of the study.

The data gathered and analysed provides the tool for the formation of the SI (the pilot of the subsequent design guideline) and the design guidelines (discussed in subsequent sections).

Kitchenham et al.’s (2002) research guidelines for planning and implementing research into software engineering were applied in this research (see chapter 3). However, in some instances, some aspects of the guidelines were omitted as being unachievable, due to being considered irrelevant in the context of this investigation. In other cases, it was considered unfeasible to implement the procedure prescribed in the standards.

Discussed below are some instances where the guidelines for the data gathering and analysis, as adapted by Kitchenham et al (ibid), were not implemented in this investigation (see chapter 3 for a discussion of the guidelines employed in this research).

In the experiment design category (see chapter 3), guideline D4 (‘Restrict yourself to simple study designs or, at least, to designs that are fully analyzed in the statistical literature. If you are not using a well-documented design and analysis method, you should consult a statistician to see whether yours is the most effective design for what you want to accomplish’) was not implemented in this investigation, as it was considered irrelevant, given that this investigation employed minimal statistics and is based on a mixed methods design.

Guideline D7, also in the same category (‘Use appropriate levels of blinding’), was not implemented, as it was considered irrelevant to this investigation, as this statistical application was considered unnecessary.

In the conducting of the experiment and data collection category; guideline DC2 (present measures, such as the kappa statistic), as in this project investigation, employed inferential statistics the data analysis was limited to the chi test (see chapter 5).

Guideline DC 4 ('For surveys, monitor and report the response rate and discuss the representative of the responses and the impact of nonresponse'.) was not implemented, as the survey method of data collection was not employed in this research.

In the analysis category guideline A1 ('Specify any procedure used to control for multiple testing'), multiple testing was not applied in this investigation as the researcher was of the opinion that such a practice would prove redundant. Instead, the triangulation of various methods of data collection was considered to be more viable, as it provided more robust information as well as a greater level of depth.

In guideline A2 ('Consider using blind analysis), discussed above (in the experiment design), this guideline was not implemented as it was considered irrelevant to the research investigation.

Guideline A3 ('Perform sensitivity analyses') was not implemented, as it was considered impractical due to physical, time and subject constraints.

In the interpretation of the results category, guideline I1 ('Define the population to which inferential statistics and predictive models apply'), no direct inference was made from the findings of this investigation; rather, what was done was based on a recommendation based on the findings of the research.

Regarding guideline I2 ('Differentiate between statistical significance and practical importance'), this differentiation was not measured, as this investigation did not implement its findings in the design and development of a prototype which may have provided the basis for measuring the practical importance of the findings and the guidelines proposed (see appendix H).

8.6 The Research Contributions

This part of this document discusses the two main contributions of this research. It is divided into two main parts. The first section discusses the Selection Instructions (SI) and the later part discusses the Educational Computer Program Design Standards (ECPDS).

8.6.1 Selection Instructions (SI) for ASD Software

It was discovered in the early stages of this investigation that there was no set of guide tool for facilitating the selection of the computer programs to employ in this research, from the large number literacy software for children with ASD. A set of instructions were developed to facilitate this process. As a preliminary investigation the MURASD developed a set of instruction aimed that helping the selection of appropriate Educational Computer Programs (ECP) to teach early reading for researchers, educationalist in ASD, parents and guardians of children with ASD looking for a guide (Tuedor, 2006).

This section is divided into five parts. It begins with the discussion of the background to the SI, and then examines the process and procedures involved in developing these instructions and a discussion of the SI. The details of the instructions are outlined, and, lastly, their benefits, limitations and future work are discussed.

The SI were developed in this research to facilitate the selection of appropriate computer programs to teach early reading to children with ASD, as it was discovered that there were no guides or instructions for this purpose. Kuutti (1995) contended that even the limited instructions that are available in the public domain are fragmented, incoherent and impossible to apply.

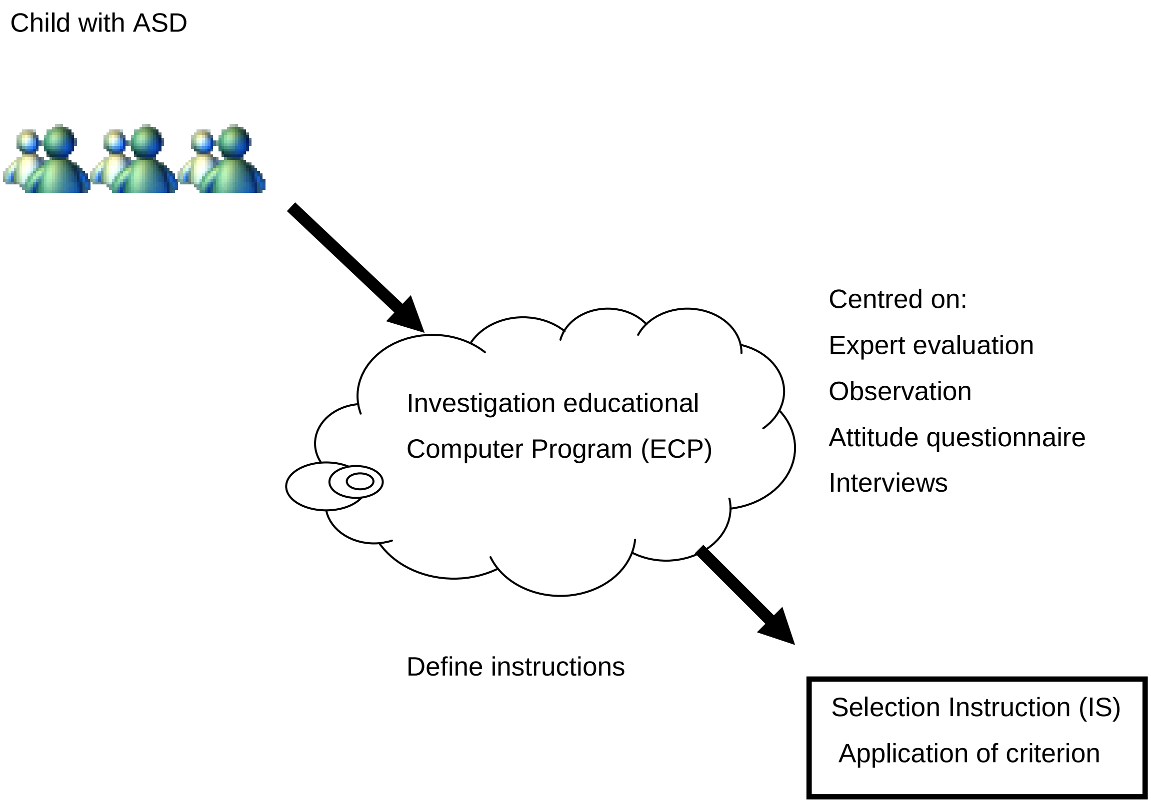
The main benefit of SI is that it guides the selection of high quality, appropriate programs for children with ASD by providing directives on what are the essential considerations that the selector needs to address and providing a list of requirements that should be considered before the selection or de-selection of a particular product, extending the recommendations of Wunder and Griffin (2002), whose workshop on choosing computer software for ASD children failed to taken into account essential factors like ALS and issues pertaining to communication, adaptability, and a profile-based approach in providing a set of guidelines.

A few of the problems involved with applying SI is that it may be voluminous-centric and general, as noted by Henninger et al. (1995). Many instructions about guidelines are known to be vague and difficult to interpret and apply, as noted by Tetzlaff and Schwartz (1991).

The main task that was completed in the early stage of this research is the identification of a computer program to employ in this investigation. Searches were conducted on the web and of the literature for suitable programs. It became clear to the researcher that some guidance was needed to help to narrow down the search for suitable programs. Failing to identify any instructions or standards to facilitate this process, the researcher decided that these needed to be developed. The SI for an early literacy computer program for children with ASD was born.

The key issues that were considered pertinent in the selection of an appropriate ECP for children with ASD are depicted below (see figure 8.1). The instruction was based on issues which were considered to be essential in order for a child with ASD to interact with a computer effectively.

FIGURE: 8.1: EMPIRICAL BASIS FOR THE SELECTION INSTRUCTIONS CENTRED ON CHILD COMPUTER INTERACTION AND EXPERT EVALUATION



The term “Model” in this research refers to the presentation of the essential component that must be present in any appropriate computer program developed for children with ASD and severe learning disabilities. The model (and subsequent instructions) proposed involves the converging of various aspects of learning, taking into consideration the issues of literacy, learning, ASD, learning disabilities and HCI. These instructions served as a medium for facilitating the selection of the programs involved in this investigation. The SI are divided into five sections, which are subdivided into the questions which the reviewer of any computer program needs to answer in order to determine if the program being considered meets the needs of the targeted users.

Criterion 1 (aim of using the technology and learning objectives)
Criterion 2 (program content and usability)
Criterion 3 (skills of the use and learning style)
Criterion 4 (psychological issues; memory and perception)
Criterion 5 (communication issues and assistive technology)

Materials

The sources employed in designing these instructions are based on reviewing the literature, interviews with professionals in the field of HCI and the researcher’s own experience. The SI employs evaluation methods:

Heuristics, as advocated by Nielsen (1994), the Model Human Processor (MHP), supported by Card, Moran and Newell (1983), and the Rare Event Theory (REL) theory, advocated by Nelson and Tjus (1997), Nelson et al. (2001) and William et al. (2002). Other sources employed in the design of the instructions are based on the literature, which include the Alliance for Technology Access (2000) and Parents Let's Unite for Kids (PLUK, 2000).

Procedure

The first task is to identify computer programs to employ in this project. Twenty computer programs were identified using two measures (measure A; superficial examining of content, measure B; aesthetic and usability) were utilised to choose the programs used in the MURASD research (appendix C). The computer programs were scored based on these two measures; the programs with the three highest scores were included in this investigation.

The general application of the SI involves a set of questions (see appendix D) based on the five criteria (as noted above). Within the context of this research, a questionnaire was implemented by the assessor[9] of the computer program (the program can be a full or demo version)[10] . The program is evaluated using the SI. The score for each question is recorded and calculated at the end of this process; the total scores recorded must be mainly positive responses in order to determine the selection of the program; if less than half of the responses are positive, the program should be de-selected. This method can be applied to as many programs as desired; the program with the highest score will be deemed to be the most suitable.

The same procedure as discussed above should be applied. Caution should be applied regarding the proposed instructions, as knowledge of the proposed user (the child's likes and dislikes) should be considered as paramount.
Detailed below is a discussion of the criteria, detailing their content and application along with their benefits and limitations.

Criterion 1 – the aim of employing technology and learning objectives

Criterion 1 begins the search for a computer program which will support learning to read in children with ASD. This criterion helps to familiarize the reviewer with the various types of computer program as well as the pedagogical styles employed. In this criterion, the reviewer explores the crucial issues that need to be considered at the beginning of the search for suitable computer programs. These questions relate to why they were considered as part of the repertoire of learning tools for the ASD child. These questions allow the identification of the child's learning objectives and compare them, as prescribed by the software developer.

Some of the categories and pedagogical-style computer programs considered are listed below.

[9] The term 'reviewer' means the person looking to employ the technology as a learning tool for a person with ASD, who could be a teacher, speech therapist, parent or guardian of a child with ASD.

[10] A demo program is a cut-down program usually designed to give prospective users an overview of the whole.

Criterion 1.1: Types of Computing Programs

This aspect of the criterion enumerates the various types of computing technology available in the public domain and highlights the features and functions they provide. The categorisation of the programs is based on the classification listed in appendix H, they are:

- Computer aided or assisted instruction (CAI)
- Computer-based learning (CBL)
- Computer-assisted learning (CAL)
- Hypermedia
- Multimedia

(See chapter 1 and appendix D and H for more details).

Criterion 1.2: Pedagogical style

Some of the pedagogical styles available in the design of computer software include:

TDP= Tutorial drill and practice

PS = Problem solving

S= Simulation

EG= Educational games

RP/ERP = Reading programs or educational reading programs

The listing of the pedagogical styles available enables the reviewer to select the best pedagogical style that is considered most suitable for the child. The pedagogical styles are employed in various computing programs (see chapter 1 and appendix D; for an explanation of the various pedagogical styles, see appendix h). Listed below are explanations of some of the pedagogical styles.

Criterion 2 - Program Content and Usability

Criterion 2 tackles the issues relating to the content and usage of the program (usability) being assessed. This criterion is subdivided into two sections. The first section of instructions examines the issues that relate to the program content. The subsequent sets of questions deals with customisation and usability issues (examining how easy the program will be for a potential ASD user to use).

Criterion 2.1: Program Content

The reviewer of the technology, in this section, is given a set of questions that highlight the pertinent issues that relate to the actual wording and usability (information displayed on the interface) of the computer program. This section seeks to determine the appropriateness of the subject taught, the instructions provided by the computer program, and the ease by which the intended users can understand the instructions provided by the program.

Criterion 2.2: Customisation

Another set of pertinent issues enumerated are those relating to customisation. Children with ASD differ in terms of their tendencies and preferences, as contended by Frith (1989) and Wing (1996), who noted the varying characteristics and degrees of this condition. Given the verification of this condition, having the option whereby a program can be customised or adapted to meet the users' needs and preferences could facilitate the ease of use of computer programs in teaching new words (or any other subject) to children with ASD.

Customisation provides the option for the computer program to be tailored to the requirements and preferences of the intended user. Customisation could be applied to the following areas in an educational computer program:

- Graphic User Interface (GUI)
- Complexity of the program and aesthetics
- Functionality and interactivity
- Adaptability

Criterion 2.3: Graphic User Interface (GUI)

The graphic user interface in the context of this investigation is the visual presentation (computer environment) that encompasses the icon, menus, and dialogue boxes of the computer program on the screen. A user (who, in this research, is a child with ASD) can select or activate the options by clicking on the mouse, typing on the keyboard or touching the screen.

Criterion 2.4: Complexity and Aesthetics

The complexity and aesthetics of the computer interface should be made "ASD-friendly", which, in the context of this study, refers to the needs and preferences of ASD children. The layout of the background screens and the font size, colour and contents of the page on the interface should meet the needs of the intended user (or there should be a customisable option in the program). The level of complexity in the structure of the page should accommodate the fact that children with ASD can only focus on a limited number of activities.

Criterion 2.5: Functionality and interactivity

The function and interactivity of the pages in the program should be made customisable, whereby the level of interactivity (in the form of animation or speed of navigation) can be increased or decreased to meet the needs and preferences of the intended users.

Criterion 2.6: Adaptability

Adaptation is the ability to load a user's profile at the beginning of a computer session (cited by Moseley, 2005). Adaptation provides the intended user of a computer program with some level of autonomy and meets their requirements. Using an adaptive system enables the records and profile of the user to be uploaded before a session or task and to respond accordingly to the predetermined users' needs.

It is crucial when employing computing technology to promote learning in ASD children to provide an environment in which alternative or additional technology can be supported, in order to provide an optimal learning experience for the user. Adaptable software and hardware should be made available for ASD users of computing technology. It is vital that a program selected as a learning tool for a child with ASD is designed to accommodate other additional hardware or software, which the child may need. This criterion highlights the issues relating to the structure and content of the computer program. The reviewer of the technology of the computer program examines the content of the program in order to determine its suitability for the purpose at hand (which, in the context of this inquiry, is to teach new words).

Criterion 2.7: Usability issues

Aspects of heuristic evaluation questions were adapted within the context of this investigation. Questions relating to the ease of use of the proposed computer program were highlighted. Questions aimed at enabling the reviewer of the technology of the computer program to examine in some detail the pertinent questions that will expose the usability problems (the likely usage problems) are enumerated for the reviewer of the technology to deliberate on, in order to determine the appropriateness of the program for the intended user.

Criterion 3 – The Skills of the User and Learning Style

Children with ASD have some abilities and disabilities which are a direct result of their syndrome (Siegel, 2003). Powell and Jordan (1997) call for the recognition of ASD abilities and disabilities; only this will allow children with ASD to develop a method of learning which minimises their disabilities and capitalises upon their ability to learn.

In this context (noted above), criterion 3 highlights the pertinent issues that relate to ASD learning disabilities and advocates that a program that caters for the learning needs and preferences of children with ASD should be considered appropriate. The approach entails the reviewer of the technology of a program designed for an ASD user to examine it in order to determine whether or not it makes provision for the ASD learning style.

The set of questions portrayed in these instructions (criteria) present essential issues, which include:

- The users' learning needs and the preferences of ASD users.
- The developmental age of the prospective user.
- The academic level of the prospective user.
- The repertoire and prior skills; how these impact on the use of the computer program.

ASD learning style is a term used to describe the learning needs and preferences that are characteristic of ASD children. The learning style proposed is based on proven methods and empirical observations about how ASD children learn with regard to their needs and preferences.

Criterion 3.1: ASD learning needs and preferences

The needs and preference of an ASD child need to be taken into account in any appropriate computer program, as contended by Powell (2001), who stated in a review of how children with ASD should be taught that the ASD style of learning should be incorporated into any learning strategy employed with them. This is vital, as its absence will limit the opportunities that the computer technology and learning experience can offer a child with ASD. Details about the learning needs and learning style of children with ASD can be found in chapter 1.

Criterion 3.2: Developmental age

The reviewer of the computer technology proposed for use by an ASD child has ensured that the computer program being investigated is at the right developmental level and age for the intended user. As children with ASD develop at a level which is different from the typical user, any program targeted at these children must be based on the development age of the proposed ASD child. Samples of the developmental and academic levels may be combined with the child's educational statement, as well as his/her diagnostics assessment results.15

Criterion 3.3: Academic level

The academic level, in contrast to the development level, investigates the learning level of the child with ASD rather than their current stage of mental and emotional development. One of the benefits of embarking on this venture is that the computer program is viewed in terms of what the child should be learning at their academic level by employing a computer program, thereby integrating the appropriate learning stages of the child using a computer as a learning tool. The P11 is employed in the UK as a curriculum for children with special needs. The P level could be employed in determining this level by the reviewer of the technology. Both the developmental and academic levels in ASD can be different, as in a TD child. The reviewer of the technology will have access to the child's academic levels; which may vary from one ASD child to another. These levels should be applied in the evaluation of the appropriateness of the computer program.

Criterion 3.4: Repertoire of prior skills

The skills that a child with ASD may already possess could be incorporated into the topic taught, thereby building on things previously learnt. The reviewer of the technology, using the SI, is given a list of questions that need to be considered in order to advance the prior knowledge of the ASD child, as well as teach him/her new knowledge or skills via the computer program.

Summary of criterion 3

Criterion 3 highlights the pertinent issues that the reviewers of any program should explore before considering recommending the program. An appropriate computer program should combine all of the above elements; namely, the users' learning needs and preferences, the developmental age of the user, the academic level of the user and the prior skills of the child, to provide the optimal benefit for a child with ASD. Details of ASD learning style and how it impacts on learning are discussed in chapter 1 of this thesis.

Criterion 4 –Learning Psychological Issues

Criterion 4 explores the psychological issues that need to be considered in the selection of an appropriate computer program for children with ASD. It addresses the ways to alleviate some of the cognitive problems

[11] The P Level or P scale is used in the UK to determine the level of development of the pupils; it is based on the national curriculum and tailored to children with special needs.

that children with ASD may encounter when using computer technology; for example, the so-called 'mind blindness' of ASD (Baron-Cohen et al, 1985). This research noted the inherent problems in children with ASD, which include problems with generalisation, problems with making inferences and information processing, and cognitive problems and their effect on social skills and learning; an example of this was noted by Baron-Cohen et al (ibid), who investigated where children with ASD failed to answer the belief question.

Some of the problems that children with ASD face include the problem of understanding how other children are thinking (mind blindness), problems in making inferences, difficulties transferring what they have learnt in one condition across to other similar conditions and generalisation problems (Wing, 1996).

The reviewer of the technology for a child with ASD needs to be aware of these psychological problems, and should examine whether the computer program will address, minimise or alleviate some of these problems.

Criterion 4.1: The Model Human Processor (MHP)

This criterion employed the Model Human Processor (MHP) as part of the component used in the formation of the SI that looks at the learning problems in ASD and how the computer program can be employed to alleviate some of these problems. The MHP model attempts to model people as information processors; it focuses on issues relating to mental activities involving perception, affordance and memory.

The MHP in the context of this investigation generates a check-list of instructions that are practical and can be applied by a reviewer of computer technologies for children with ASD in the selection of a reading program that takes into account these learning problems. Pertinent considerations are included as part of the summative (subsequent to) program design process. Evaluation questions based on the MHP promote the principle of a user-centred (see the next section) design and reduce some of the learning problems that ASD children can face when using technology. The MHP is discussed in greater detail in chapter 3.

Criterion 5 - Communication and Assistive technology

In employing computing technology to teach children with ASD to read or to assist them with other learning tasks, the issue of communication must be considered carefully, as the process of active learning demands a response to instructions and the communication of an appropriate response, as suggested by Peeters (2001).

Criterion 5.1: Communication

Communication is the exchange of messages between children to express their needs, thoughts, ideas and feelings (Autistic Society, 2004c). Communication is generally done through the use of language (verbal communication), gestures or pointing in ASD children. A characteristic problem of ASD is a difficulty in communicating and, even where speech is present, there may be problems with regard to abnormalities in the amount, content and grammatical structure of the language used (Damasio and Maurer, 1978).

It is of great importance that the form of communication tool employed to teach reading or any other subject to ASD children is at an appropriate communication level for the children to be able to understand, comprehend, and respond to the instructions of the educational computer program (see chapter 1).

This criterion focuses on the reviewer being provided with questions that highlight the communication issues in children with ASD and provide the prospective user (a child with ASD) with appropriate communication tools. The various types of communication media available include augmentative communication devices and the use of photographs, images and symbol-based communication, which need to be supported by an appropriate program for children with ASD.

Various communication tools are employed in the teaching of children with ASD at the various stages; see section 8.6.2 (these stage are typical examples; some stages can be altered, combined or omitted), where learning through communication tools is introduced and applied in the teaching of these subjects (in their educational life), together with a list of the strengths and weaknesses of each tool.

Criterion 5.2: Assistive Technology

Another pertinent issue that criterion 5 emphasizes is the role of assistive technology in learning for a child with ASD using computer technology. Assistive technology is any technology that enables an individual with a disability to compensate for specific problems and deficits, and so achieve productivity, independence and success, according to their needs and interests (Alliance for Technology Access, 2000).

Assistive technology products can range from cognitive tools, such as software focusing on categorisation, matching, problem solving, memory, and word prediction, to hardware, such as switches and ergonomic mouse, as stated in Rehab (2004). Assistive technology empowers children and adults with learning disabilities with new abilities to communicate without speech or sight, to manipulate their environment, and to demonstrate their cognitive abilities in non-traditional ways (Stokes, 2002).

This criterion asks relevant questions about the computer program being assessed in order to determine if it supports other learning equipment that a person with ASD may need in supporting (the assistive tool) their learning with a computer program. It also highlights the role of assistive technology output and input devices in learning and gives the reviewer of the computer program the opportunity to explore the various additional technologies that may benefit the child i.e. additional output devices can include visual output facilities, such as enlarged screens and symbol-based images (that assist in reducing perception problems), and input devices, such as touch screens and trackballs.

Discussion of the SI

The SI and subsequent standards (see the next part) were developed to facilitate the selection (and the subsequent design) of appropriate ECP for children with ASD. The instructions contain questions that highlight the pertinent issues to be considered in the selection of appropriate ECP for children with ASD. The issues considered to be crucial to this investigation range from the learning style of ASD, the objectives of the proposed users of the technology, practical matters and logistics, past experiences and a repertoire of other external factors, which may come into play when using technology to reinforce learning, and were deliberated upon in the development of these instructions, in order to reflect the learning needs of children with ASD and to provide these individuals with the opportunity to benefit from the use of computer technology.

The SI was developed to facilitate the selection of appropriate computer programs to teach early reading (or other skills) to children with ASD, via computer-assisted learning. The selection instructions provide a foundation for more research into providing instructions to assist professionals, and the parents and guardians of ASD children in the selection of appropriate ECP for reinforcing the children's learning to read.

On an individual basis, the benefits of each criterion include:
Criterion 1 provides the familiarization that the reviewer needed in order to identify the various types of computer program as well as the pedagogical styles employed. Its benefit is that it gives the background knowledge that a reviewer requires in order to determine which of the various types of computer program are preferable; which, in many instances, may be unfamiliar to the professionals as well as the parents and guardians of children with ASD.

Criterion 2 highlighted the importance of a good graphic User Interface (GUI), the right level of complexity, the importance of appropriate content and pleasing aesthetics, and the effective use of functionality, interactivity and adaptability in the computer software.

The benefits of criteria 3, 4 and 5 are: in criterion 3, the issues relating to the users' learning needs and preferences, the developmental age of the user, the academic level of the user's details, and the learning style of the intended users were highlighted. Criterion 4 offered instructional guidance on issues relating to the psychological problems that affect children with ASD that should be addressed by using computing technology (see above and appendix D). Criterion 5 addressed the importance of communication and assistive technology in supporting the learning needs of children with ASD.

The limitation of the instructions with regard to criteria 1 to 5 is: criterion 1 is limited due to its lack of depth regarding the topics discussed. A greater degree of depth is needed to give a more in-depth understanding of the types of computer program in the public domain and the pedagogical style on which the computer programs are based. In criterion 2, the usability-based question was misplaced; these questions will have been better served in criterion 1, along with other design and structural questions.

Criterion 3 attempts to tackle the needs and preferences of children with ASD, in order for the reviewer of computer programs for children with ASD, through the sets of instructions, to identify a computer program that capitalises on the learning strengths of the intended users (children with ASD) and minimises their limitations; in order to optimise their learning opportunities when using computer programs. The issues discussed in this part are of the essence; however, a greater degree of depth is needed in defining the developmental ages and academic levels of the children. In the area of past experiences and skills, the various repertoires of skills and experiences that the children with ASD may have acquired were not adequately explored within the context of this investigation.

Criterion 4 discusses the psychological issues that are characteristic of ASD. This criterion attempts to expose as well as propose ways in which the reviewers can identify, through the sets of instructions, whether or not the software evaluated addresses the psychological problems (see above) of children with ASD. The MHP applied in this criterion was not discussed in sufficient depth. The process by which the learning problems in ASD will be alleviated by this model was not discussed. Additional work is needed on this criterion and the mode of its application to the SI.

Criterion 5 discusses the issues that relate to communication and assistive technology (the additional tools needed to support the users' learning by employing additional technology).

Several aspects of this venture could have been executed differently: to begin with, the SI was applied only to this investigation. A more extensive application of the guideline is needed to refine and further extend this instrument.

In summary of this evaluation, the selection instructions are too generalist and fail to investigate the context of the topic or intention (early reading) in sufficient depth. Due to the vast subject area that this selection instructions covers, there is a problem of what is the appropriate level of depth that should be covered in each topic during the instruction. However, as this instruction is the first of its kind, there is room for further redevelopment and refinement, either through this study or by other researchers looking to take this instruction further.

The novelty of the SI is that it is the first systematic attempt to provide a set of procedures for facilitating the design of appropriate computer programs to teach reading (and other skills) to children with ASD.

The further application of these instructions is needed in order to refine these instructions further and to make them applicable to other subject areas. More work is needed to extend these instructions to include:

- An extension of the instructions that would include other aspects of learning (for example mathematics, science, geography, awareness of the environment, social interaction, etc.) and other learning disabilities.
- An extension of the instructions and subsequent ECPDS standards to include other subjects and aspects of learning

8.6.2 Educational Computer Program Design Standards (ECPDS) for ASD software

Trehin (1994) recorded that there is a miss-match in the technology of educational computer programs designed for children with ASD. He noted that the programs were inadequate due to the fact that they are either too technical or written by experts in ASD who have little technical knowledge.

The standards proposed in this document attempt to bridge the gap between how children with ASD learn (as advocated by professionals in ASD) and how to design appropriate computer technology to support this endeavour, with a view to bridging the gap between both sets of professionals.

The standards discussed in this section are an extension of the SI (discussed in the previous section) which served as the preliminary investigation. The standards proposed in this chapter are based on a stringent application of the design principles of the system design (HCI) and a thorough knowledge of ASD. It investigates issues surrounding ASD and the factors that could impair learning to read in children with ASD whilst using computer-instructed learning. Remedies to alleviate and, in some cases, eliminate some of these problems will be suggested with a view to capitalising on the abilities of children with ASD and minimising their disabilities.

The standards take into account all of these components which includes;

- Effectiveness of the program
- The deficiencies of ASD
- The design of tailor-made systems that address individual learning requirements,
- Reading
- The learning styles of children with ASD and how they learn to read

and sub-components which includes;

- Software engineering
- The design and development of systems
- HCI
- usability

These issues are essential to the development of systems to support early reading skills in children with ASD.

Some of the benefits of computing technology include increases in focussed attention, overall attention span, in-seat behaviour (where the child sits down to undertake tasks for longer), motor skills and general skills (from computer to non-computer skills), as stated by Swenson and Kingman (1981), Panyan (1984) and the National Autistic Society, 2008f).

Computer technology has also been noted to reduce negative or unwanted behaviour in ASD. This includes decreases in self-stimulated behaviour, agitation and preservative responses. Other benefits include developing important day-to-day social skills, such as turn taking, cause and effect, and the imitation of sound (which can help the development of early stage speech).

However, despite the benefits of computing technology enumerated above, the learning needs of these children are ignored in the design and development of computer programs for these children, as noted by Alcalde et al. (1998) and also by data obtained from the interview results (see above). In order to develop any aspect of a program for children with ASD, it is important to understand and implement a learning style that is appropriate for these children.

Some of the abilities of children with ASD have to be channelled to compensate for some of the learning problems associated with this disorder using computer technology. It is, therefore, necessary, when designing programs for children with ASD, to take on board the requirements and preferences of the children in order to provide an environment that is conducive to their learning style. This will minimise the impact of their disability (when the child comes to learn employing technology) and capitalise on the strengths of these children.

As in the early period of the internet, when web pages were designed without following the User Interface (UI) standards, the design and development of educational computer programs for children with ASD is currently facing a similar plight, as acknowledged by Koltringer et al. (2006), who outlined the benefit of standards for facilitating well-designed computer programs. Strong (1995) called for useable, accessible computer systems, as badly designed programs lead to frustration and low productivity.

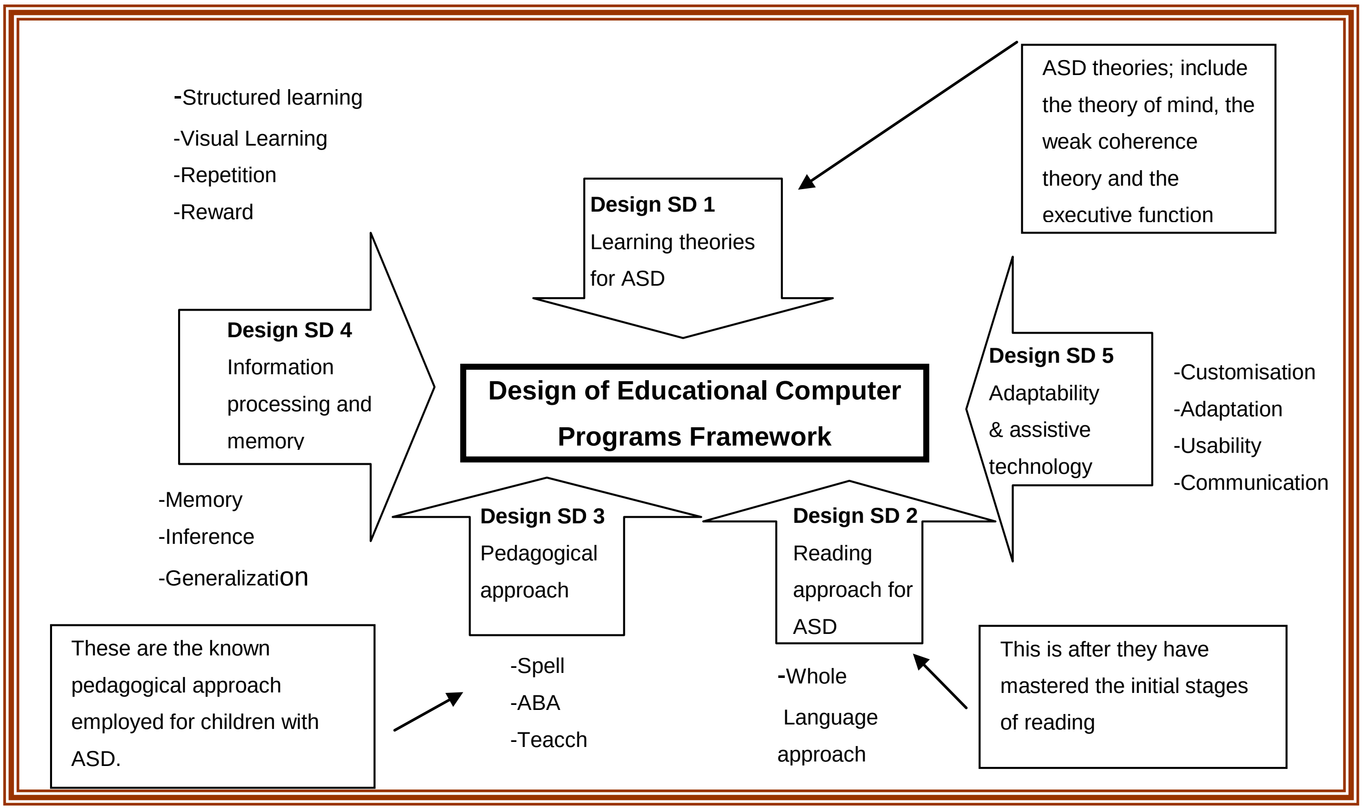
Various attempts have been make in various domains to address the standardisation issues in software design and the internet. One such attempt is the ISO TS 16071 (Gulliksen and Harker, 2004). This venture is aimed at providing a standard for promoting accessibility to all users of technology. The Comite Europeen de Normalisation (CEN) is another attempt to create standardised computer products and services through conducting CEN Technical Committees, Workshops and Focus Groups. This forum makes it possible to meet the requirements of users through employing samples of users in the creation of the standards.

Many standards in the public domain are ineffective, as noted by Henninger et al. (1995), who argued that many standards fail to support the developer of computer systems, since they are not content-specific

The standards proposed in this Middlesex investigation address this identified gap, and aim to provide a guide for the design of ECP. They are employed to reinforce the teaching of early reading in children with ASD. This standard proposed will combine aspects of the attributes and learning style of ASD, an effective teaching approach, and suitable reading methods for children with ASD, implementing an adaptable and adaptive system design. This will form a new theory for designing appropriate ECP for children with ASD. It eliminates issues that are redundant and opts for the essential elements that should be present in the design of ECP for children with ASD.

The standards consist of 5 design standards, including learning theories for children with ASD, the reading approach for ASD, the pedagogy of ASD (appropriate teaching methods for ASD), information processing and memory and lastly, adaptability and assistive technology for ASD, as depicted in figure 8.2. Each of the ECPDS feed into the design framework which is employed to generate the standards (see Appendix H) for the design of appropriate computer programs for children with ASD.

FIGURE: 8.2: ECPDS FOR ASD



User centre design

The principle of user-centred design was employed as a standard that governs this design framework. This principle advocates that any good system design should involve the proposed users throughout the lifecycle of any product, as noted by Preece (1993). The advantage of this approach is that, since the users are actively involved in the design process, the success of the system is more likely. A system based on system consideration alone without the input of the intending user will be ineffective and redundant. The next point to consider is how to understand the proposed users of the computer program evaluated (based on the principle of user-centred design).

Materials

The sources employed in designing these standards are based on reviewing literature, three empirical studies ii –iv.; which includes interviews with professionals in ASD (TAs) and HCI experts (HCs) and the researcher's own experience. The guidelines employ three evaluation methods, including Heuristics (Nielsen, 1994), and Rare Event Theory (REL; Nelson and Tjus, 1997, Nelson et al., 2001). Other sources employed in the design of the standards were derived from the literature, which include the Alliance for Technology Access (2000), William et al. (2002), and Parents Let's Unite for Kids (PLUK, 2000).

Detailed below (see table 8.2) are the findings of the empirical studies linked to the design standards (see appendix H for the standards or guideline and section 8.6.2 for the discussion of the design guidelines).

TABLE 8.2 THE FINDINGS OF THE EMPIRICAL STUDIES LINKED TO THE DESIGN GUIDELINES

ECPDS STANDARD NUMBER	FINDINGS FROM EMPIRICAL STUDY ii	FINDINGS FROM EMPIRICAL STUDY iii	FINDINGS FROM EMPIRICAL STUDY iv	FINDINGS FROM OTHER RESEARCH
1	G: 4,5,6,7,8,10, 11,17	G: 5,6,7,8,15	G:6,7,8,9,10,11,12,13,14,15,16	G: 17
2			G: 18,19,20,21,22, 23,24	
3				R: A,B,C,D,E
4	G: 32		G: 25,26,29,30	G:,27,28,31
5	G: *44,45,* 54,55,62,65	G: 34,36,37,38,40,41,46-62,64-67	G:43,47,48,49,50,51,53,56 ,57,62, 64, 65	G: 33,35, 39,63

The letter 'G' represent guideline whilst, the number that follows it is the number of the guideline.
The letter 'R' represents recommendation; the number that follows it is the number of the recommendation (see appendix R for more information).

Procedure

The general application of these standards (see appendix H) is implemented as a formative evaluation which can be applied both at the beginning and throughout the lifecycle of the design process. The proposed designer of the computer program is expected to apply the standards at each stage of the software development as an educative tool that will facilitate the needs of the intended user. The designer have to ensure that any trade-off or omission of any of the standards is not at the expense of the ASD user and, where this cannot be avoided, it should be kept to a minimum.

The ECPDS is based on a framework of 5 standards, each of which deals with the five pertinent aspects of designing an educational computer program to support early reading skills in children with ASD (aged 5 to 10 or at the beginner reading stages). Discussed below are the 5 standards.

ECPDS 1- Learning Theories for Children with ASD

ECPDS 1.1: Learning

The designers and developers of computer programs for children with ASD need an understanding of the strengths and difficulties of ASD in other to optimise the learning opportunities that the program will provide. This initiative of capitalizing on the strengths of the children should be integrated into the design and development of educational computer systems. The way in which this can be achieved is by understanding the ASD learning style (see chapter 1), and the theories of ASD (see chapter 3). ECPDS 1 can be found appendix H (questions 1 to 17).

Learning in ASD in not a natural process; children with ASD have to be helped to learn (Powell and Jordan 1997). Children with ASD may often have accompanying learning disabilities, and their uneven abilities may be manifested in noticeable strengths and weakness. Discussed below are the areas that the computer program needs to address.

One of the foremost considerations should be how to model the proposed program in order to reflect the needs of the users. Some of the areas dealt with include; appropriate development level, the information processing problem, the attention and motivation problem and other learning strategies.

In providing teaching tools for children with ASD, it is important to be aware of the different developmental levels of the children (see chapter 1). It is pertinent to understand the varied ways in which children with ASD can be taught to learn using computer technology and to apply strategies at each stage that are appropriate to the child's developmental level (this is discussed further in the standards (learning style) of this model). Powell (2001) postulated that children with ASD should be taught to learn. A learning model of ASD will facilitate this. A detailed study of how children with ASD learn is to be incorporated into the design of educational computer programs for children with ASD in order to alleviate some of these aspects (see appendix h). The recommendation of this investigation is that computer programs should capture the essence of the ways in which children with ASD learn, and provide a structure for the integration of the "learning style" of ASD into educational multimedia computer technology.

Reducing information processing problems in children with ASD is an aspect of the design process that may be difficult to implement in designing any educational computer programs for this group. This problem will be covered in greater depth in design standard 4. With regard to the learning style of ASD (that deals with the problem of information processing), the recommendations are listed below:

- A small quantity of words should be taught, with a gradual, linear structured approach, as suggested by Eisele (1980).

- New tasks should be introduced slowly in other avoid overwhelming or confusing the child with ASD, as suggested by Powell (2001). The program should be consistent and highly structured in order to support the ASD style of learning.

- Children with ASD may have problems with over-selectivity, whereby they can only focus on one or two aspects of the five senses (auditory, visual, touch, taste and smell), as noted by Schreibman et al. (1977) in an investigation into the problems of over-selectivity in 16 children with ASD.

- The designer should, therefore, capitalise on the visual senses which are reported to be favoured by children with ASD, as noted by the National Autistic Society, 2008b) and limit the sensory level present in the program by providing customisable options in which the amount of sensory output can be regulated to benefit children with ASD.

- The child with ASD may focus on small details and ignore everything else; for example, focussing on a spot in a photograph rather than the entire photograph. The designer should therefore emphasis what is being taught to alleviate this problem.

- Children with ASD process information in chunks (see design standard 4 below), and may absorb information in its entirety, through the so-called "chunk style learning", without editing it for relevance. By so doing, they may absorb irrelevant information and ignore what is being taught by the computer program (ASD Spectrum Australia (Aspect), 2002). The design of an interface for children with ASD should minimise the content of the program as well as ensure that it only contains essential content and features.

- Children with ASD find visual information easier to process, as noted by Powell (2001) and Peeter (2001). Children with ASD will benefit from a learning strategy that capitalises on the fact that it involves visual learning. The design of any interface for children with ASD, therefore, should emphasis visual information and minimise other sensory output in order to maximise learning.

- Children with ASD will benefit from a strategy in the interface design which supports repetition, as reported by Swenson and Kingman (1981), who contended that the repeated reading of the same text has been found to aid learning in students with ASD. They investigated (ibid) the effectiveness of employing CAI in teaching children with ASD, and noted substantial gains from employing CAI to improve learning in 12 children who participated in the study. HERO (2008), the official online gateway to education and research, prescribed repetition as an effective learning tool to teach children with ASD and learning disabilities. Lau et al. (2006), in an investigation involving 5 children with ASD, noted the benefits of repetition as a tool in multimedia programs (although no evidence was provided in the investigation), and concluded that computer programs should provide a medium through which children with ASD can learn actively until they have mastered what is being taught. Akin to this, Strydom and Plessis (2002), in a similar investigation, noted that repetition promotes the recall of people's names. Repetition can be applied with a combination of the content and multimedia elements of the program, such as text, images, sounds and animation, to produce mastery of the task and to promote the learning experience of the users.

- Repetition as a strategy in the ASD learning style should be applied with caution, as excessive repetition in the computer program could lead to boredom and frustration in the user, as recorded in the findings of this investigation (see chapter 5).

ASD is characterised by certain behavioural abnormalities. This may include hyperactivity, attention deficit problems, motivational problems, lack of imagination and social problems. In trying to employ ECP to educate a child with ASD, it is vital to take these factors into consideration and work to address them wherever an opportunity to do so arises. Antonio et al. (1978) noted some of these abnormalities, comparing them to certain forms of brain-damaged adults (as a result of accidents).

Insufficient attention was paid to moderating the learning problems of children with ASD. Tjus et al. (2001) noted a lack of consideration of attention deficit problems and Trevarthen et al. (1996) noted a lack of reflection leading to a lack of motivation in these children.

There is a need to design an ECP that compensates for the problems of attention deficit in sustaining learning in children with ASD. Animation and bright colours are some of the tools that can be applied by designers to alleviate some of their attention problems, as suggested in the interviews (see chapter 7), and prompting and rewards (the rewards can be verbal or material for the correct response or encouragement to try again for an incorrect one) can motivate the children, as noted by Lau et al. (2006) and in the observation results (see chapter 5).

Heimann et al (1993; 1995) in the LITT project noted that the children with ASD were more frequently 'off task' than those with intellectual disabilities. Since they lack the strategy to direct their learning pattern, they need supervision from their teachers or an adult. This was noted also during the observation investigation (see chapter 5).

The designers have to develop a program to support an adult (who could be a teacher or parent and guardian) to moderate the learning from the program by including assessment records of the child’s performance and a periodic pop-up screen (which could be optional), whereby the adult comes to restart the various parts of the program.

ECPDS 1.2: Communication in Computing Technology for ASD

Trevarthen (1998) noted that a carefully adjusted communication strategy (along with teaching or therapy) will advance learning in children with ASD. The empirical evidence from the literature professionals in ASD (see chapters1 and 3) suggests that a vast array of communication tools should be made available in the computer program to support learning and communication opportunities.

Children with ASD employ different forms of communication methods at various levels of their development. This could be verbal (the use of words or speech) or non-verbal, which may include communication methods such as pointing, gesturing, sign language, the use of objects, taking the hands of an adult to show what is desired, the use of the Picture Exchange Communication System (PECS), the use of Visual Interaction Augmentation (VIA) (Siegel, 2003) or the use of words and symbols.

It is of paramount importance that the appropriate form of communication tool is employed in teaching reading to these children. The stages of communication for typical non-verbal children with ASD are listed in table 8.3, along with a discussion of these tools (see appendix H for more details).

TABLE 8.3: COMMUNICATION STAGES IN ASD

APPROACH	COMMUNICATION LEVEL AND STAGES	STRENGTHS AND WEAKNESSES
Object	1st stage	**Restrictive**
PECS	2nd stage	**Less restrictive**
Symbols	3rd stage	**Less restrictive**
Sign Language	4th, 5th stage	**More flexible**
Augmentative Communication	**4th, 5th,6th stage**	**More flexible**

Peeters (2001) noted the importance of adapting teaching to accommodate the brain functioning of children with ASD. Peeters stresses that an object may have particular meanings for many children with ASD who struggle to understand the world, which they may find confusing.

The motivation behind the adoption of these sets of design standards is, it channels the educators and designers' attention towards issues pertaining to receptive and expressive communication (that children with ASD need or may employ in using an ECP product) in the design and delivery of the educational materials through the computer program.

Signalong or sign language (as it is sometimes called) is a means of communication designed especially for children with learning disabilities. It is based on British Sign Language (BSL). Nearly all the signs are unaltered and the most iconic signs are selected, where a choice exists. There are a few signs which have been adapted for ease of use and some signs have been invented where no appropriate BSL signs could be found or where ambiguity has arisen.

A computer program showing a video of a person signing (which will benefit non-verbal ASD children who use sign language; see the assistive technology section below for more details) as well as all of the multimedia elements present (sound, animation, text and images) will benefit children with ASD, as found in the video recording conducted in this study, where the subjects responded positively to this medium employed in the computer program (see chapter 5).

Communication aids can be used to support children with communication difficulties, using symbols, pictures, and sound (real and synthetic). This can be added to the images on a computer program in order to promote continuity in the learning and communications tools (such as an augmentative communication aid; for example the Dynavox),[12] employed in the child's education (see design standard 5; for adaptive tools).

[12] The Dynavox is a communication device for children who need assistive technology in order to speak. The child types the word or selects the symbol for the word they want to say and the device vocalises it.

The computer can be designed to accommodate the adaptation of the program by the teaching staff in order to create symbol-based learning and communication activities using the standard symbol system (Inclusive Technology, 2002).

Symbols are line drawings accompanied by words. Some children with ASD prefer written to spoken words (hyperlexia). It is good practice to accompany visual aids (text- or image-based) with spoken words. Also, it is important for understanding to be present in the person with ASD before any text is introduced.

The use of symbols was employed in the pre- and post-test (see chapter 4), and it was recommended as a medium support for learning to read by the ASD co-ordinator and the communicational assistant (see chapter 7).

Any of the communication methods listed above could be used in designing ECP. However, it is recommended that the target users' needs should be examined closely in order to determine the best way in which to incorporate their preferred communication methods from the options offered by the computer program. It is essential that educational computer programs are designed to be as inclusive as possible by catering for a wide range of user needs (Gulliksen and Harker, 2004). This is an essential aspect of software program design that can be over-emphasised.

Children with ASD are often at various developmental ages, so, in teaching children with ASD or in designing technology for them, it is important to determine the language age of the target audience in order to be able to develop a computer program at an appropriate level for each user, employing the appropriate method of communication.

In designing technology for children with ASD, it is important to determine the language age of the target audience in order to be able to develop a computer program at an appropriate level for the users, employing the appropriate method of communication (see design standard 5).

Other considerations that need to be added to the computer programs include cueing techniques, incorporating various sounds to create awareness in the children and developing 'Hands on' tasks. Children with ASD learn through the performance of tasks (learning by doing). The hands-on approach in ASD learning is essential in using technology to teach children with ASD, as the children can implement what is learnt on a practical level, thereby giving them the opportunity to master the task and become active learners.

In designing any computer program for children with ASD, the designers must incorporate a hands-on task that children with ASD will find meaningful and enjoyable, as in the 'teach and drill' pedagogical approach (see chapter 5).

ECPDS 1-Recommendations

The recommended learning approach for designing ECP to teach new words to children with ASD should be based on the Autistic Learning Style (ALS) (detailed above). This strategy, along with the other considerations and strategies (discussed in detail below), should be applied to provide an atmosphere that is conductive to learning for these users.

This design standard detailed many of the essential characteristics of ASD that need to be considered and, where possible, measures to alleviate or minimise the impact of this condition need to be applied to the design process of these programs. One of the issues that were considered pertinent to the success of a computer program for these children was considering their learning style and communication.

The findings of this investigation (the four empirical studies) indicate that the learning style of the children were a key aspect of the design favoured in the two computer programs evaluated.

As discussed above, these problems were noted and, based on these findings the guidelines were developed (see appendix H). This design standard is limited by the fact that some of the ECPDS are not detailed and lack the depth that may expose the level of detail that each recommendation needs. Some of the suggestions made in other studies (for example, Trevarthen et al. (1996), Powell and Jordan (1997) and Peeters (2001)) are based on suggestions and recommendations rather than on usual evidence.

There is also the issue of how to translate the recommendations into standards; for example, in the aspect of communication, there are various types of communication tools available, so it is difficult to know which one will benefit a child with ASD. A way to counter this problem is to have the main communication tool supported by the computer program.

This can be problematic, as designers may not have that level of knowledge of or expertise in ASD. It is up to the practitioners and educationalists of ASD children to provide this information. The limitation of this is that limited, off-the shelf ECPs for children with ASD will be available and specialist (made-to-measure) programs are expensive to develop.

ECPDS 2: The Reading Approach for ASD

The literature reviewed in this investigation (see chapter 2) and the findings from the interviews (empirical study investigation iv; see chapter 7) indicate that children with ASD will benefit from a learning strategy that capitalises on the Autistic Learning Style (ALS), which may include factors like visual learning, as noted by Connor (2004), Powell (2001) and Peeter (2001), task-originated learning, such as learn-and-drill and reward, as suggested by Eisele (1980), the whole language approach, as suggested by Connor (2004), who noted that children with ASD process information in its entirety, and the interview data (see chapter 7). ECPDS 2 can be found appendix H (questions 18 to 24).

The reading content of the educational program has to be in the context of the national curriculum for children with learning disabilities, as stipulated in Planning, Teaching and Assessing the Curriculum for pupils with learning Disabilities, English (2001).18

The levels of development of the pupils in special education schools, the P levels,19 are determined using the P Scales. The P levels include stages P1 to P8. In the context of this study, the participants are between stages P1 to P3 (for examples of the characteristics of the children at this P level, see appendix R).

There is no research in the public domain on standards for the design of educational computer programs to teach early reading skills in children with ASD. The investigations that are available only test if children with ASD will learn to read using ECP without dealing with the design and methodological issues involved. Williams et al. (2002), Heimman et al (1993 (b), 1995), and Tjus (1998) recorded success with reading among children with ASD when using ECP. However, the reading methods and the design considerations were not discussed.

This investigation advocates the whole language approach from the interview findings (see chapter 7), as well as the ASD learning style, as evident from the investigations (see design standard 1).

The whole language approach will support the information processing styles (due to the problems they have with learning, as noted by Powell (2000)) that are characteristic in these children. By so doing, this research is advocating employing one of their strongest assets to promote learning (new words) by emphasising the strongest asset of these children, such as their visual learning. At a later stage of the learning process, the phonics approach could be gradually introduced as an addition to this strategy. This should be introduced gradually, as the complexity of using this strategy to learn to read words from the way they are pronounced or the way they sound may be too complex for many children with ASD. The interview results and literature from other research favour the whole language approach (the traditional method) to supporting the ALS of the children.

The whole language method focuses on the need to identify words before any meaning can be constructed from them. This approach finds theoretical support from Goodman and Goodman (1979 cited in Sutherland 1992) and Adams (1996). The child gains an understanding of the words from the content, pictures and objects. This method primarily uses flashcards as a medium to teach reading which is currently used, to some extent, in most special needs schools, where symbols and words are used to facilitate communication. Given that children with ASD are visual learners, this method is beneficial to ECP design.

The use of whole language is considered most suited to the teaching of new words to children with ASD, as it focuses on visual learning. The interviews held with the ASD professionals (the TAs, speech therapists and ASD co-ordinator) confirm that children with ASD will benefit from a medium which emphasises a concrete, visual and spatial approach, as stated by Peeters (2001) and Powell (2001).

The limitations of the whole language approach to reading proposed as part of the framework include the dangers that the children may face in their learning endeavour, due to the fact that English language has irregular spelling and writing patterns (as acknowledged by Adams, 1996), the problem of this approach being applied inconsistently and the fact that there may be contradiction in the approach by the designer (as noted by Dudley-Marling, 1995). The long-term implication of this is that it will reduce the children's literacy learning experience, as they will fail to acquire the skills-based instruction provided in the phonics method, as noted in Wikipedia (2008).

In this research, these issues were taken on board; hence, the proposition that, at a later stage, the phonics approach should be introduced to the children when they are more avid readers in order to afford confusing them due to their information processing difficulties. The ALS proposed takes into consideration the difficulties that children with ASD have in processing new information; for example, these children have problems processing a mass of new information which would appear easy to TD children, since children without the disorder are able to make connections between the new information and information previously learnt. Information processing in children with ASD is highly reliant on rote learning (whereby information is processed in chunks or as a whole), as noted by Lau et al. (2006). Rote learning is the ability to remember things that are not directly related or geared towards the thought process; for example, recalling part of a favourite film. This process involves a lack of understanding about the purpose, function, rules and time constraints which children with ASD find difficult to learn. Children with ASD may have difficulty in making connections and with categorisation skills, and so rely on rote learning. Therefore, employing the phonic approach when teaching them reading, especially during the early stages, will be counter-productive, as these children lack the memory or disposition to employ this method.

Children with ASD have problems with organising structuring meaning in the context of what is learnt, as noted by Powell (2001). While non-autistic children use meaning to organise learning through the integration of what is already known into a mental framework which helps them to interpret new events, future occurrences, and anticipate and solve problems; in ASD children, this is not the case. Children with ASD have a cognitive style of thinking in detail. They are unable to see how different pieces of information form a whole picture. This suggests that an approach whereby the whole is in focus will be beneficial to these children, as advocated in the whole language approach.

Due to the problems that children with ASD have in learning, employing one of their strongest assets to promote learning new words will facilitate their learning. At a later stage of the learning process, the phonics approach could be gradually introduced as an addition to this strategy. This should be introduced gradually, as the complexity of employing this strategy in learning to read words from the way they are pronounced or the way they sound, may be too complex for many children with ASD.

Repetition is a tool that facilitates the learning of new skills in children with ASD. As these children have memory problems, repetition has been noted to alleviate some of these problems, as stated by Lian et al. (2006). The whole language approach aims to support the repetitions of words learnt which will be a useful tool in an ECP for children with ASD. This MURASD project noted that children in the SM learnt more words as a result of these tools, as noted in the interview results (see chapter 7).

The learning approach should be made more interesting and playful, in other to sustain the child’s attention. Children with ASD suffer from problems with maintaining attention, as stated by Jordan and Powell (1990), which can be alleviated when they employ computers to learn to read if the programs are designed to be interesting and fun, as suggested by the TAs in the interviews (see chapter 7) and by Nind (2001).

ECPDS 2- Recommendations

The recommended learning approach to teaching children with ASD new words should include a combination of the whole language approach and the autistic learning style strategy which is focused on visual learning and repetition (discussed above). The use of whole language will be most suited to the teaching of new words to children with ASD, as it focuses on visual learning.

The limitation of the reading approach advocated is the lack of direct evidence from other research that links these suggestions. However, the suggestions from the various authors are based on the empirical observation and professional experiences of the authors.

ECPDS 3: Pedagogy for ASD

There is no cure for ASD. The only strategy available to improve the lives of children with this condition is through early diagnosis and early intervention (Siegel, 2003). Intervention involves a combination of various strategies which may include the teaching of everyday life skills (hygiene and personal care), formal education and therapy.

This section (design standard 3) discusses the various pedagogical teaching practices currently employed to teach children with ASD. The aim of this design standard is to familiarise the designers of computing programs with the pedagogy for ASD children in order to incorporate these principles into their designs; which will be a good practice (encourage the principle of user-centred design) and beneficial in the design of effective, appropriate computer programs. No attempt was made to analyse these principles, as they are empirically supported by Jordan and Glenys (1999). The next task is to identify a suitable type of educational program for children with ASD in order to guide the design process. ECPDS 3 recommendations can be found A – E (see appendix H).

There is no common consensus on how children with autism should be taught. Most pedagogical practices used to teach children with autism rely on the behaviourist (as stated in Sutherland (1992) and Piaget's theories of learning (as noted by Taylor (1996). Children with ASD and SLD are usually taught life skills and other subjects according to the National Curriculum for Special Needs (as stipulated in the Department for Education and Employment (1999)). It is only after developing the ability to master their environment and showing signs of understanding during learning that the teaching of other subjects, such as reading and mathematics, is intensified, as acknowledged by the findings of the interviews in this investigation (see chapter 7).

These children are taught according to the P level scheme, which is an adaptation of the National Curriculum to accommodate the needs of the children. Teachers have to reappraise and adapt their teaching in response to the changing needs of the children (Qualifications and Curriculum Authority, 2001). As with the introduction and avocation of any teaching strategy (conventional teaching methods and when using ICT), it is necessary to have strategies that are tailored to the learning needs, learning styles and preferences of the children.

Some of the teaching methods and strategies in these schools involve the Spell approach, the Teacch method, the High Scope approach and Applied Behaviour Analysis (ABA).

ECPDS 3.1: Structure Positive Empathy and Low Arousal (SPELL)

SPELL is the acronym for Structure Positive Empathy and Low arousal. SPELL training aims at identifying the underlying issues of the disability and providing a means of communication for these children (National Autistic Society, 2008c).

SPELL is the framework for the staff training provided by the National Autistic Society schools, and forms the ethical basis for the intervention they provide. Training is geared towards providing an understanding of, and a response to, the needs of both adults and children.

This ECPDS standard identifies the uniqueness of each person with ASD and aims to develop strategies that are individualistic yet which share a common identity, by interlinking any common issues that are peculiar to this group. This helps to promote personal development by working to reduce the difficulties associated with autism and also builds on the strengths of each individual with this condition (ibid).

The aim of the SPELL framework is to sustain the following:

- Structure: The environment and structure should be predictable and promote independence and reduce anxiety.
- Positive (approach and expectations): encouragement and the skills acquired.
- Empathy: an understanding of people with ASD and an attempt to see the world through their eyes.
- Low arousal: the environment should reduce arousal.
- Links: links with other professionals involved with the adult or child and their parents/guardians.

This method has been proven to be effective in many ASD schools in educating children with autism. Unlike many other programmes, this method is mainly used in schools that are affiliated to the organisation in which this method was first developed. This approach can be incorporated into the design principles of any program designed for children with ASD. A program developer needs to consider carefully his/her target audience before utilising this method.

ECPDS 3.2: Applied Behaviour Analysis (ABA)

Applied behaviour analysis (ABA) dates back to Skinner and the animal experiments which showed that food rewards (the immediate target for specific behaviour) can lead to behavioural change (Saffran, 1998).

The basic ideology behind this method of teaching is that children with autism often learn very little from the environment but are capable of learning in a very structured environment. This programme, therefore, emphasises the importance of having a structured environment in order to promote learning in children with

ASD. This ideology assumes that, since the excesses and difficulties of autism result in learning blockages, intensive and structured teaching would help autistic children to overcome their problems (ibid).

The ABA programme emphasises the importance of having a structured environment after a certain age in order to promote learning (learning to read, writing, mathematics and other subjects). The ABA approach employs methods which help to maintain the skills learnt, to ensure that the learnt skills are applied and not forgotten and also to promote learning. A commonly used sector of the ABA programme is the Lovaas method, also known as the UCLA (University of California Los Angeles) programme. The Lovaas method is a home-based intervention model for early intervention, involving 40 hours a week of intensive therapy (National Autistic Society, 2008e).

The aims of ABA are:

- To create the prerequisites for children to learn naturally.
- To maintain and use the skills learnt.
- To create a very structured environment that will optimize learning.
- To use computers to support learning.

Most of the above listed aims have made this method popular amongst the parents of children with ASD. However, the issues of funding and the long period of intervention (8 hours of intensive intervention) limit the usage of this approach.

ECPDS 3.3: The High Scope Approach

The High Scope approach is a way of working with young children that is derived from Piaget's theory of child development and is based on the idea that children learn best from activities which they plan and carry out themselves. The High Scope approach promotes the principles of 'independence, active learning, collaboration and respect for individuals', whereby the child acquires the reading behaviour as well as being an active participant in learning and supported by CAI (High Scope Educational Research Foundation (a), 2008).

Amongst the many benefits of using the High Scope approach is the fact that it develops the ability for self-expression in children so that they can speak about, write about or show, through pictures or movements, their experiences to others.

The problem is that these children may lack the ability and skills required for self-expression, as advocated by this approach. This teaching approach is less commonly used than TEACCH and SPELL in specialist schools for ASD children.

The principles underpinning the teaching method discussed above could be applied to educational multimedia computer programs and would go a long way towards making these products easier for children with ASD to use and so promote learning.

3.4 TEACCH Approach

The Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) programme originated in 1966 at the University of North Carolina in the USA. It began as a research project to provide services for children with ASD and their families. The Teacch programme is intended to equip children with ASD and their families with the help and skills they need in order to function effectively within their communities. This may be at home, at work or in education (National Autistic Society, 2008d). Some of the benefits of utilising the Teacch approach include:

Improved adaptation (of strategies to suit the child or adult), parent collaboration, individual-based assessment, structured teaching, skills enhancement, cognition and behaviour therapy and generalised training (whereby the whole understanding of the child is encouraged).

Other pedagogical practices not discussed but employed in teaching for children with ASD include; the daily life therapy (a programme which originated in Japan, whose teaching approach is based on Japanese culture aimed at integrating children with ASD with TD children; Quill, 1989), the integrations approach (where children with ASD are taught with TD children) and the interactive approach (a relationship-based approach), as detailed by Jordan and Jones (2000).

ECPDS 3.4: Categories of Computing Programs

The main categorises of computing technology available in the public domain are (see above) Computer Assisted Instruction (CAI), Computer Based Learning (CBL), Computer Assisted Learning (CAL), and Hypermedia and Multimedia. The pedagogical styles employed by the educational computer programs are based on the methods of Tutorial Drill and Practice (TDP), Problem Solving (PS), Simulation (S), Educational Games (EG) and Reading Programs or Educational Reading Program (RP/ERP) (see appendix M) and the previous section for more details).

The most appropriate method for children with ASD is a combination of the Tutorial drill and practice (TDP), Reading Programs or Educational Reading Program (RP/ERP and Educational Games (EG), in a multimedia environment. Research has shown that children with ASD respond to multimedia-based computer programs, as is evident from the investigations by Heimann et al. (1995) into the effect of employing CAL within a highly motivating and interactive multimedia environment, which found an increase in word reading and phonologic awareness in all 11 of the children with ASD.

Tjus et al. (1998) investigated whether computer programs can enable children with ASD to improve their reading skills and found that all 13 of the children with ASD could read more rapidly following the intervention. Williams et al. (2002) investigated whether computer-based instruction or personal instruction would promote reading in 8 children with ASD. It was found that the children spent more time reading when they used CAI than when using the traditional method.

There is a need for a correlation between the teaching methods employed in school and the approach used to design ECP for children with ASD. Care needs to be taken to ensure that the teaching methods provided by the computer programs are consistent (and do not conflict with the methods used in the school) in order to avoid confusing the users. This will promote consistent good practice. One way of achieving this is to incorporate the teaching principles employed in education, which have been proven to be successful in teaching these children, into the program design. This is the main strength of this design standard.

ECPDS 3- Recommendations

Any of the teaching approaches discussed above can be employed as the pedagogical principle that guides the design and development of ECP for children with ASD (as recommended by Jordan and Jones, 2000). For example, most of the teaching methods used for children with ASD stress the importance of structure and consistency for these children. Such factors should, therefore, be reflected in the design and development of computer programs.

ECPDS 4: Information Processing and Memory

In educating children with ASD, it is essential to understand the problems they have with information processing and memory, as stated by Lau et al. (2006), who provide a forum from which this part of the design framework is formed. This research proposes that the media will act as an external memory to fill the gap that between their working memory and long-term memory in children with ASD. ECPDS 4 can be found appendix H (questions 25 to 32).

This section discusses the problems that children with ASD have with information processing and memory, with a view to recommending as part of the standards the provision of ways to alleviate some of these problems through the design of ECP that will provide a suitable learning tool to facilitate the learning of new words.

In ASD learning, meaning is dysfunctional (Wing, 1996). This may be as a result of problems with the frontal lobe of the brain, as reported by Baron-Cohen and Bolton (1993), who, in their post-mortem investigation of ASD, reported that this dysfunction is consistent with damage to the frontal lobes (which control planning and control), limbic system (which controls emotional coordination), and the brain stem or cerebellum (which control motor coordination). This affects information processing and memory in children with ASD.

ECPDS 4.1: Information Processing

Information processing problems in ASD children can be linked to the children's inability to make inferences and generalise (perception), as noted by Frith (1989, 1972) and Wing (1996). Frith (ibid) noted that children with ASD, unlike TD children, have difficulties in applying rules and have an inferior rote memory in an investigation of 20 ASD children, 20 TD children and 10 'subnormal' children. The term 'subnormal' employed in this investigation is inappropriate and derogatory, and what the author meant was children with varied disabilities. The investigation found that, although the children with ASD show a high degree of adherence to the rules (they recorded scores of 60% and 65%); they experienced problems in applying self-generated rules compared to the other groups. Baron-Cohen et al. (1985) noted that these children have difficulty in making inferences and transferring what they have learnt in one condition across other, similar conditions, as noted by

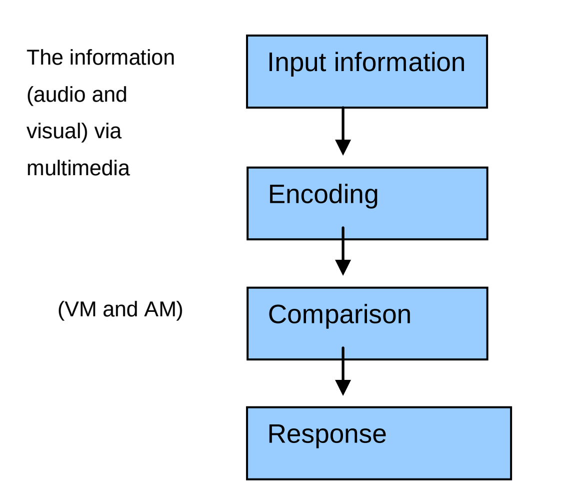
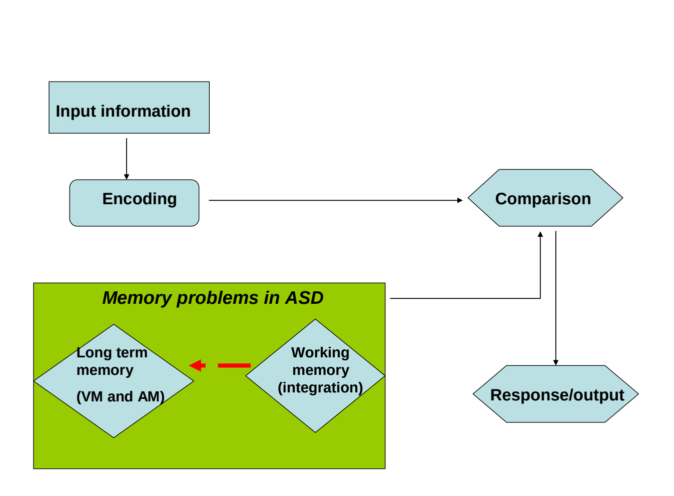
Powell and Jordan (1997). Other information processing problems that these children face may include cognition and perception problems (ibid).

Perception is associated with an aspect of the nervous system whereby input or information is held while the nervous system makes sense of it (information received). Children with ASD may have difficulty in processing a mass of new information which would appear easy for other children. They may focus on small details; the so-called “over selecting” (or minute detail) and ignore everything else that is happening; for example, focussing on a spot in a photograph rather than the entire photograph. In other cases, they may focus on the entirety of a thing; the so-called “chunk or whole style learning”, without editing it for relevance, or may not absorb any information, simply ignoring everything and focussing on nothing (Autism Spectrum Australia (Aspect), 2002).

The structure of learning in TD children involves the encoding of information, followed by its comparison in the context of other information known, followed by a response to and organisation of information for future use (storing in memory), as depicted in figures 8.3 and 8.4. This is a far cry from the processes involved when a TD child comes to learn in the same condition (these images attempt to capture the problems of ASD children whilst using computing technology).

Lindsay and Norman (1997) noted that the structure of learning in TD children involves information entering and exiting the four stages of encoding, comparison, response selection and response execution. This is different in children with ASD who, due to the problem that they have with memory (Powell 2001), depend on rote learning, which is the ability to remember things that are not directly related or geared towards the thought process; for example, recalling part of a favourite film. This process involves a lack of understanding of the purpose, function, rules and time constraints which children with autism find difficult to learn. Therefore, the child relies on rote learning constantly. Children with ASD may have difficulty with prediction, in making connections and with categorisation skills.

The difficulty that children with ASD have in learning is that they have problems integrating new information in their working memory (WM) with the information in their long-term memory (LM) in other to learn or provide the needed response, as depicted in figures 8.3 and 8.4. In figure 8.3 (TD children), the arrow moving from one aspect of information processing to the next indicates that there is a smooth flow of interaction, whilst the same is not the case in figure 8.4 (ASD children), where a catalyst is needed to facilitate this process.

FIGURE: 8.3: INFORMATION PROCESSING IN TD CHILDREN	FIGURE: 8.4:INFORMATION PROCESSING IN ASD CHILDREN
	

The catalyst for facilitating the information processing and memory problems by employing multimedia in learning, as noted by Mayer's 'Cognitive Theory of Multimedia' or Multimedia Learning (2001), stresses the benefits of employing visual and audio multimedia as a learning tool. Lau et al. (2006), in an investigation into information processing in 5 children with ASD using multimedia, proposed an information processing model. This theory notes the benefits of visual images when applied in parallel with audio material in a multimedia environment, as noted by Paivio (1971), who noted that this will aid memory, as stated by Mayer and Morena (2000). Lau et al., however, failed to provide evidence to back-up his/her propositions.

The multimedia program will act as an external memory (with retrieving qualities) which will bridge the gap when learning to read (as applied in the language learning investigation by Lau et al., 2006). The information which is displayed by the computer program will trigger what is already stored in the long-term memory to enter the short-term memory. Based on this, there will be an integration between what is already known (in the long-term memory) and what is learnt from the computer (input into the WM) to produce the new words learnt.

ECPDS 4.2: Problem of Meaning and Reliance on Rote Learning

Children with ASD have problems with applying meaning to and organising what is learnt, as noted by Powell (2001), who suggested that these children find it difficult to detect the meaning of what is being said from the clues offered by the expression of the speaker. TD children use meaning to organise their learning by integrating it with what is already known to form a mental framework that will help them to interpret new events and future occurrences, and anticipate and solve problems; in ASD children, this is not the case. These children have a cognitive style of learning; they tend to think in detail, and are unable to see how bits of information form a whole picture.

The solution to the meaning problem in ASD is for the ECP to act as a catalyst whereby the multimedia educational computer program projects the means to process information for the child by acting as an external memory by presenting the word through the interface. The ECP presents the content (the word to be learnt), for example, the word ‘cup’ by multimedia (text and image of the word), and this is later followed by a video of a child drinking (animated); there has to be consistency (the cup used to teach the word and the cup in the video recording should be exactly the same in order to avoid confusing the child). This process will bridge the gap between meaning problems as well as information processing problems in the child. This recommendation is similar to the research by Lau et al. (2006), who investigated language. However, this Middlesex research investigates reading and the level of complexity in it is omitted in Lau et al.’s research.

Other disabilities that are associated with ASD that may hinder a child from learning through computer technology are fine motor skills and sensory problems. With fine motor skills, for example, a child may have problems holding or manipulating objects, so an assistive technology device (tracker ball mouse) 20 may be employed to alleviate some of these difficulties (see design standard 5 below). With the sensory problem, the program should be designed to be adaptable (customisable), so that it can be adjusted to the right level of stimulus for the child (see design standard 5).

ECPDS 4- Recommendations

The standards proposed in this section advocate ways of alleviating the information processing and memory problems that children with ASD face when learning (especially when the employ ECP).

This design standard details the processing of information in a child with ASD, as distinct from TD children, as noted by Lau (2006), with a view to guiding the design process in order to optimise learning opportunities for these children. This Middlesex research extended this model by extending the role that visual and audio elements have to play in ASD learning using ECP by including other aspects of ASD learning style, such as repetition and prompting, which were not included by Lau et al. (ibid). Whilst Lau et al.’s research dealt with language, the Middlesex research applied this model (modified) to reading.

The limitations of this design standard include the lack of sufficient depth in the information processing model for ASD with regard to employing multimedia as an external memory process device to facilitate learning to read in children with ASD.

ECPDS 5: Adaptability and Assistive technology

Children with ASD are frequently excluded from enjoying the benefits that computing technology provides due to a lack of proper consideration of the ASD condition in the design of computer programs for ASD children, as noted by Shapiro (2002) in a review of computer technology for children with ASD. The findings of this investigation (see chapters 5-7) and the literature review (see chapter 2) indicates that there is a need for educational computer programs to reflect the needs and preferences of these children. ECPDS 5 can be found appendix H (questions 33 to 65), as well as two additional questions 66 and 67.

Educating or designing appropriate educational computer programs for children with ASD requires an understanding of their learning style and preferences, as stressed by Powell (2001), who acknowledged these in a bid to improve the children's learning ability. Trehin (1994) stressed the importance of having a good understanding of the ASD child's strengths and difficulties. This section discusses the issues in the design process in three aspects: usability, adaptability and assistive technology.

Usability evaluation is an essential part of the interface design process. Ivory and Hearst (2001) noted that usability affects the extent to which a user achieves his/her goals efficiently and effectively. The Heuristic evaluation method (a discount usability method) is one of the most commonly used methods. Heuristics was devised by Molich and Nielsen (1990) and Nielsen and Mack (1994) as an evaluation method for inspecting an interface. It is based on ten principles (or Heuristics) by which to identify problems (Somervell and McCrickard, 2005).

The motive for adding the Heuristics evaluation method is for it to serve as an expert evaluation method to employ before the children with ASD and their teachers or teaching assistants (who will act as facilitators) are recruited to test the computer program. This method is essential, given that the designers may have limited assess to the children in order to recruit them to test the program.

The benefit of this method is that it may act as a simple, inexpensive way to identify the usability problems in a program or system; in the context of this investigation, a modified version of this method was employed to guide the usability aspect of the design and development process. This method was conceived as useful in guiding the usability aspect of the framework for designing appropriate computer programs for children with ASD, based on it successful applications in investigations, such as that by Somervell and McCrickard (2005); this investigation examined the use of heuristics to support the creation process in two classes of user (expert and novice).

Nine of the ten heuristics was modifications (as recommendations and added to this design standard); the heuristics that deal with the documentation were omitted, as this aspect is catered for in other parts of the design standard.

Sauro (2004) noted the pertinent limitations in the Heuristics evaluation method. He claims that it is a 'less-than exact process', is vague and misses too many problems, while Cockton and Woolrych (2002) note that the Heuristics evaluation method is limited by the fact that it is a cutting corners method that is prone to error and full of risks, as it focuses on only the superficial problems of a system.

ECPDS 5.1: Adaptation Systems

In order to employ computing technologies to reinforce learning in children with ASD, it is essential to understand how to present information to children based on their learning style. Adaptable systems allow the loading of a user's profile at the beginning of a session. Using an adaptable system enables the records and profile of the user to be uploaded before a session or task and to respond accordingly, as prescribed by Moseley (2005) when employing adaptive and adaptable technology. It is crucial, when employing technology to promote learning in ASD, that alternate or additional technology should be supported, in order to provide an optimal learning experience for a child with ASD. Adaptable software[13] and hardware[14] could be utilised with a computer program as an "add on" (additional) device. It is also of vital interest in the design of adaptable programs for children with ASD that the levels of flexibility and complexity that the program contains are considered in the early stages of the system design. Table 8.4 lists the various categories of adaptation possible in a system (see below).

TABLE 8.4: CATEGORIES OF ADAPTATION SYSTEM

CATEGORY	DESCRIPTION	APPLICATION AND MOTIVATION
1	Changes that honour the original design	Changes necessitated for appropriateness reasons
2	Stylistic change only: honours the initial design	Changes necessitated for stylistic reasons
3	Changes do not honour the initial design. Solution negotiated and applied	Changes necessitated by appropriateness problems
4	Changes do not honour the initial design. Changes made for stylistic reasons only.	Stylistic reasons only; changes here are negotiated and the designers are unenthusiastic about these as they are not important to the users.

Another way in which adaptable computer technology can be applied to the design of appropriate ECP for these children is through the application of the profiling method.

ECPDS 5.2: Profile-Based Programs

To map the individual differences in ASD, as well as applying the learning style of ASD (discussed in the previous section), there is a need for a computing program to be robust and proactive in accommodating user variance and diversity. One way of capturing these is by designing a program with adapts itself to the children; this provides the intended user of a computer program with some level of autonomy in the use of the program (ibid).

[13] Computer software is a series of instructions that perform a particular task called a program. There are two categories of system software (made to control programs like operating systems i.e. Microsoft XP) and application software (any program that processes data i.e. Word).

[14] Computer hardware is the physical component of the computer program; including any peripheral equipment, such as printers, mouse devices, etc.

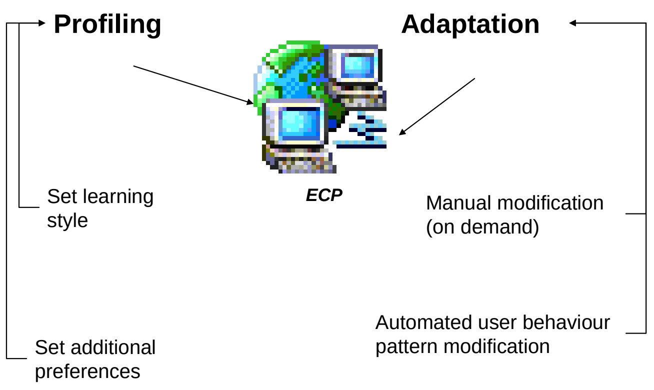
Applying these principles to design principles, whereby the user profile can be loaded onto the program from the onset of the computer interaction (the adaptable system approach) and a process whereby a computer program can record and respond to the behaviour of the user (the adaptable system approach) (Moseley, 2005), is a proactive way of implementing the findings from the data collected in the study, that suggests a need for the ASD learning style to be applied to the design of the computer programs being evaluated.

Profile-based systems are intuitive and proactive, recording and responding to the users by adapting themselves to suit the users' needs. The designers of educational multimedia computing technology for ASD should promote the design of an adaptable system, as this may help to alleviate some of the learning needs of children with ASD that may have been omitted in the profiling of their user needs (where the users' profile is loaded onto the system at the beginning of the session).

Profile-based systems can be employed in two ways; the first is to configure the system to allow its adaptation to the user's preference or abilities. This can be done using the users' profiles or self-adaptation. 'Self-adaptable' is a phrase coined to reflect the intuitive aspect of the proposed system, whereby the computer program or system adapts itself to meet the ASD child's behaviour pattern. Kules (2000) demonstrated the potential of adapting to the users proficiencies when using a program, but there was no evidence to substantiate his propositions.

Adaptable elements that can be applied in the design of appropriate ECP can be divided into 4 categories (see table 8.2). In the context of this research, categories 1 and 3 (see table 8.3) are proposed. The ECP will be able to set the child's learning style and preferences (as discussed below) and, in addition, the program will be designed to support additional features or technologies, such as the font colour and size can be changed on demand or as the child's needs may dictate, whilst in the case of profiling, the child's learning style and preferences can be set prior to using the program (this does not have to be repeated, except if modification of the existing profile is required), as depicted in figure 8.5.

FIGURE: 8.5: TAXONOMY FOR ASD ECP



The areas of the ECP in which the adaptable features can be applied to a program for children with ASD are detailed in table 8.5.

TABLE: 8.5: AN ADAPTABLE AGENT FOR ASD

DEVICES	OPPORTUNITY PROVIDED
Communication device Images, photographs, symbols and text	Alternate communication medium to suit the child's level of communication
Interface preference Screen display, background colour and font colour	Alternate screen display to accommodate the preferences of a child with ASD
Motivation (rewards and prompting)	Alternate medium of motivational aid to support and sustain motivation and attention
Mentoring of program usage by the system	Provides records to monitor the child's progress
Sound input and output	Alternate input device to accommodate the child's auditory preferences
Navigation (Response time)	Alternate way of providing an appropriate level of navigation based on the child's abilities

Some of the benefits of developing profile-based programs for ASD children are that the system can be specific to each individual's needs. ASD is a spectrum disorder, where no two autistic children are the same.

This will help to promote autonomy based on individual needs. One of the limitations of developing an adaptable system for ASD is the level of complexity involved in this process. It is of similar importance that any program designed for children with ASD should support assistive technology devices.

ECPDS 5.3: Assistive Technology

Assistive technology empowers children and adults who have learning disabilities with new abilities to communicate without speech or sight, to manipulate their environment, and to demonstrate their cognitive abilities in non-traditional ways, according to the Technology-Related Assistance for individual with Disabilities Act of 1988 (Public Law 100-407).

Assistive Technology is “any item, piece of equipment, or product system, whether acquired commercially, off-the-self, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities”, as stated by Raskind (2000).

Assistive technology can be employed to improve the performance and functional capacities of children with ASD in the areas of: language and communication, attention skills, independence in daily functioning skills, organization skills, academic skills, social interaction skills and the understanding of the environment, as recommended by the National Autistic Society (2008a).

Assistive technology programs can be employed in three forms. Firstly, they can be used to alleviate some of the perception problems (making sense of information perceived by the senses) associated with ASD by moderating the volume of incoming information (visual, auditory and touch) from a computer program or system. Secondly, they can help children with ASD to provide the right response to the information. Lastly, they can support the cognition deficit in children with ASD.

Assistive technology can be hardware or software. Appropriate educational programs for ASD should support additional devices that a child with ASD may need in promoting learning and in employing computing technology. Detailed in table 8.6 are the types of assistive technology tools available for children with ASD and their functionalities.

TABLE: 8.6: ASSISTIVE TECHNOLOGY DEVICES FOR ASD

DEVICE	DESCRIPTION	FUNCTIONALITY
Hardware		
Big keys and big keys plus keyboard	Alternative to the alphabet based keyboard	Input device
Intellikeys	Alternative to keyboard	Input device
Tracker ball	Mouse based on a static ball that rotates	Input device
Software		
Speech synthesiser and screen review	Enables user to hear the text of spoken words	Input device
Speech recognition	Enables user to hear the text of spoken words	Input device
Word predictor	Predict words typed into a program	Input device
Skill focused programs Language skills Attending skills Problem solving skills Fine motor skills Academic based skills Entertainment	Skill focused programs	Input and out put

Some of the abilities of children with ASD have to be channelled to compensate for some of the learning problems associated with this disorder by designing programs that take on board their requirements and preferences and so provide an environment that is conducive to their learning.

This design standard discussed most of the considerations that pertain to the needs and preferences of these children, thereby facilitating an individually-tailored program based on the user-centred design approach. In trying to suit the individual needs of every child with ASD, there is a trade-off, as the system complexity may become unwieldy due to the levels of variety needed to meet individual needs. The profile-based adaptable educational program was proposed. Whilst the program tries to meet the individual needs of the children, it may have omitted crucial aspects of the systems, such as the technical complexity of the program. A detailed discussion of the issues involved in the recommendations made in this section will be included in the next section (the discussion).

ECPDS 5-Recommendations

The ECPDS in this section discussed the usability issues along with the application of the adaptable principles to the design of appropriate educational programs for children with ASD. Alongside these issues, it advocates that any appropriate program designed for children with these disabilities should employ assistive technology as a crucial aspect of the standards.

8.6.3 Comparing the Selection Instructions (SI) and the Educational Computer Programs Design Standard (ECPDS)

The selection Instructions (SI) is a preliminary research which was conducted as part of an investigation into the standardization of ECP for these children. The instructions were developed to facilitate the choice of appropriate computer programs to support early reading (or other skills) in children with ASD, via CAL. The SI was developed to be used by professionals in education or computing technology, and the parents and guardians of ASD children. The SI focus on combining various topics in early reading, ASD, learning disabilities, psychology (some aspects of learning) and HCI.

The ECPDS contains questions that highlight the pertinent issues that are crucial to a child with ASD, ranging from the aim of employing technology and the learning objectives, program content and usability, skills of the child and learning style, psychological issues and communication and assistive technology. In contrast, the design standard content includes learning theories, the reading approach, the pedagogy (appropriate teaching methods), the information process and memory and usability, adaptable systems, and assistive technology for ASD.

The main benefit of the SI is that they serve as a guide to facilitate the choice of quality programs to support early reading in children with ASD by providing directives on what are the essential considerations that the selector needs to address and providing a list of requirements that should be considered before the selection or de-selection of a particular product. It extends the recommendations of Wunder and Griffin (2002), whose workshop on choosing computer software for ASD children did not take essential factors like ALS and issues pertaining to communication, adaptability and a profile-based approach into consideration in the set of guidelines provided.

In contrast, the Educational Computer Programs Design Standard (ECPDS) was developed on the basis of the central investigation into the standardization of ECP for these children (the main purpose of this research). The standard is an extension of the SI and takes into account all of the essential components (the characteristic deficiencies of ASD, reading, the learning styles of these children, software engineering, design and HCI) that are essential to the development of systems for teaching early reading skills.

The SI are based on a review of the issues relating to what constitutes good ASD literacy software, the appropriate content (of the program) and the ease of use of the program. Aspects of the child's learning style, developmental age, and academic level all need to be considered by the professional reviewing or investigating prospective reading software. Other issues, such as problems with memory and generalisation, are other areas that need to be considered. Finally, the issues of communication and additional equipment that the child requires in order successfully to employ the software need to be considered in order to check for accessibility and ensure that the software supports such technology.

On the other hand, the ECPDS provides standards that should be applied in 5 areas (as represented as part of a framework), including understanding the ASD learning theories and learning pattern, and instructions on how this can be applied to the design of the software. The reading approach the pedagogy for ASD is prescribed by this standard.

The main difference between the SI and DS is that, while the IS offers a guide for examining the qualities that will facilitate identifying what constitutes an appropriate ECP for children with ASD, the DS is regulatory; it provides a set of standards that will promote better-designed systems for children with ASD.

Another crucial difference between the SI criterion 4 (learning Psychological Issues) and the ECPDS 4 (information processing and memory) is that, in the former, the SI issues pertaining to the learning needs and preference of the ASD child are listed to help the user of the instruction to review a particular piece of software in order to determine whether or not the software addresses (or may compound) the problems with learning to read in the child. In contrast, the ECPSD was developed initially to throw light on the problems faced by the children with ASD as well as to give clues about how these problems can be alleviated when designing literacy software for these children.

Another difference is the SI criterion 5 (communication and assistive technology and ECPSD 5 (usability, adaptable, assistive technology). Whilst the SI prescribed that the reviewer consider the added communication tools (assistive technology) and child ASD may need to use a literacy software detail questions that light-this aspect are listed (see appendix D).In the ECPSD the issues the design option that can be employed in the design of the software (such as profiling; see above), communication as well and additional tools (assistive technology) were detailed in more depth.

8.7 Chapter Summary

This chapter discussed the accumulation of all of the findings of these investigations (empirical study investigations i to iii) and the formation of the SI and the ECPDS, together with the contributions of this research into educational literacy programs for children with ASD. It commenced by discussing the findings from the four empirical study investigations (see chapter 4-7), and the research methodology is examined (see chapter 3).The SI act as a guide in facilitating the selection of appropriate computer software. The ECPDS was proposed to facilitate the design of a standard that is much-needed. The chapter concluded with an appraisal of the preliminary contribution (the SI) and, later, the ECPDS, paving the way for chapter 9, which concludes this investigation.

Chapter 9

Conclusion

9.1 Introduction

The Middlesex University Research for children with Autistic Spectrum Disorder (MURASD) indicates that, for children with ASD to optimise the use of this technology, it has to be designed to meet the learning needs and characteristics of this condition. On the basis of the findings of this project (see chapters 4 to 7), the Educational Computer Program Design Standards (ECPSD) for ASD literacy software is proposed, based on the characteristics and challenges of ASD, as advocated by Trehin (1994) and Powell and Jordan (1997).

Mayer (2001) advocated a multimedia-based learning approach, which is based on the congruity of presentation, based on words, pictures which employ multimedia and cognitive structures (using the audio and visual modal). The preponderance of evidence suggests the benefits of employing computer technology in the education, therapy and rehabilitation of children with Autistic Spectrum Disorder (ASD), as reported by Panyan (1948), Heimann et al. (1993, 1995), Alcade et al. (1998), Moore and Calvert (2000) and Williams et al. (2002). Yet, there is no standardization for reading computer programs for children with ASD. Trehin (1994) noted the mismatch in the technology for educational computer programs designed for children with ASD.

One of the hallmarks of this current investigation is that it focuses on children with a severe form of ASD, unlike other similar investigations that concentrate on children with mild to moderate ASD, such as those by Heimann et al. (1995), Alcalde et al. (1998), Moore and Calvert (2000), Tjus et al. (2001) and Williams et al.(2002). They shy away from the more severe form of ASD due to the difficulties (logistics and behavioural problems) involved in working with children at this end of the spectrum. This is why MURASD had a limited number of participants available for this programme.

Researching vulnerable children with ASD and Severe Learning Disabilities (SLD) who are on the most challenged end of the autistic spectrum, is taxing due to the difficulties that these child face, which may include behavioural abnormalities, hyperactivity, attention problems, motivational problems, repetitive interest and behaviour (as detailed by Frith (1989), Crane, (2007)) and social, communication and imagination problems (as reported by Wing, 1996).

The MURASD investigation demonstrates that research involving these children as participants is achievable and that great rewards are to be gained from understanding how to help these children to learn using computing technology, if more research of this kind is executed.

The use of the observation method provided a wealth of information on the child-computer interaction, a tool that should be encouraged in researching these children. The use of methods, such as involving facilitators (the classroom assistants in this case), provided a voice for these children (who are all non-verbal), as well as adding insights into the investigation (see chapters 5 and 7).

To recapitulate, this investigation began by defining the research questions. Two literacy computer programs were employed to teach new words to 5 children with ASD in order to research how to design appropriate literacy computer programs for children with ASD and SLD.

The principles arguments in the literature examined include:

- The benefits and limitations of supporting reading in ASD children by using computing technology
- An ASD learning style is needed in teaching ASD children.
- Specialist design standards are required for computing software for ASD children
- More research is needed using participants with ASD and Severe Learning Disabilities (SLD)

The first task was to examine the past research in this domain, followed by developing the methods used to investigate this topic. The research methodology (underpinning methods) was employed to articulate the methodological issues that needed to be considered. The theories examined and included in this research include learning (psychology), literacy (education), Human Computer Interaction (HCI) and software engineering.

A made-to-measure approach, combining qualitative and qualitative data collection tools, was adopted in order to promote the research rigour, validity and reliability, applying Kitchenham et al.'s (2002) guidelines in the planning and implementation of the research methods (data collection). Four types of data gathering techniques were employed in this endeavour, which included: pre- and post-tests (empirical study investigation i) video recording (empirical study investigation ii), an attitude questionnaire (empirical study investigation iii) completed by professionals in ASD and HCI, and interviews (empirical study investigation iv).

The pre- and post-test empirical study (investigation i) was employed to assess whether there was any actual new word gain following the children's use of the two software programs.

The observation (empirical study investigation ii) was employed to record the interaction between the child and the computer software. The significance of this method is that it provides direct/first-hand information about the children's interaction with the computer software, providing a wealth of information that was later applied to the ECPDS.

The attitude questionnaire (empirical study investigation iii) evaluates the appropriateness of educational literacy computer programs designed to facilitate early reading skills in children with ASD by obtaining the attitudes of the participants. The rationale for employing the attitude questionnaire is that the data gathered using this technique can be used to support/provide more details about the evaluation of the computer programs based on the participants' attitudes (the ASD support teachers and teaching assistants and HCI professionals) towards these programs. The attitude questionnaire as a data gathering tool can help to obtain the participants' attitudes towards a product.

The interviews (empirical study investigation iv) were employed to elicit the views of the teaching assistant, as the technique for measuring the child-computer interaction was to solicit the views of the classroom assistants who were the facilitators in this research, and so could represent the children. The interviews also clarify the attitude questionnaire results (empirical study iii) that were designed to obtain the views of the participants regarding the benefits and limitations of the computer programs employed in this research, as well as the limitations of the programs with a view to soliciting recommendations on how they could be adapted for autistic users.

The aims and objectives set out at the beginning of this investigation were achieved. The preliminary investigation produced the Selection Instructions (SI), which were developed to facilitate the selection of good educational computer programs to teach early reading to children with ASD. The principal investigation formed the basis for the development of the Educational Computer Program Design Standard (ECPDS) for software for children with ASD.

This investigation brings to light an urgent need to standardize the design and development of educational computer programs (ECP) for children with ASD, as identified by Trehin (1994). Some degree of success was achieved by this project, especially in terms of conducting an investigation involving children with the more severe form of autism, who were previously unrepresented in research due to the difficulties arising from their serious behavioural problems.

The MURASD research proposed a framework which combines aspects of the attributes and learning style of ASD, an effective teaching approach, and suitable reading methods for children with ASD, implementing an adaptable and adaptive system design. This will form a new theory for ECPDS (see appendix H) for children with ASD. The standard eliminates the issues that are redundant and opts for the essential elements that should be present in the design of ECP for children with ASD.

The findings of the MURASD research are:

- Children with ASD will benefit from a design standard that incorporates the challenges and characteristics of this condition into the design process.
- The computer-child interaction in ASD children will be improved by introducing adaptable computer features.
- Close collaboration is needed between children and professionals in ASD in designing computer programs for ASD children.
- More research is needed that includes ASD children with Severe Learning Disabilities (SLD)

This research is limited, given that it provides the foundation for the design standards. It is expected that further work in this domain will help to refine and modify this framework (and standards). This thesis has covered a vast amount of ground, beginning by examining the literature related to the current design and development of computer programs for children with ASD and then conducting an empirical study and evaluating the computer programs, as well as involving professionals in ASD and HCI to add informed expertise to this investigation. Much has been learnt and new knowledge has been discovered in the domain of ASD, HCI and software development.

It was anticipated that a prototype system will be developed that encompasses most of the recommendations made in the ECPDS, but this will be transferred to a post-doctoral project, due to the time limitation of the current research.

A number of lessons were learnt in the course of this investigation, and more time should have been allocated to the data collection process; for example, the time allocated to the intervention process could have been extended. Attempts were made to remedy some of these problems by quick thinking and the adaptation of the research to minimise these problems (see chapters 4-8). Lessons have been learnt, and further research endeavours will benefit from these.

If anything, we are still far from finding an ultimate theory for formalising the standards for the design of appropriate computer programs for children with ASD.

Future work may include exploring further the potential of these standards for developing a full program that will embody and explore the ideology proposed in this investigation. New methods are proposed, yet there is still a vast amount of ground to cover, especially with regard to the perceptions of children with ASD.

The issue of repetition, which is considered in some investigations, for example in the research by Johnson et al. (2007) Strydom and Plessis (2002) and Simpson (2001), needs further research in order to determine, for instance, the level of repetition that is beneficial, as one of the findings of this investigation is the negative behaviour that was observed when a high level of repetition was present in some of the ASD children (see chapter 5).

This investigation provided a systematic guide which will constitute a first step towards standardising educational computer literacy software for children with ASD. The old hypotheses were affirmed; for example, the children with ASD were found to have learnt new words (as recorded by Heimann (1993, 1995) and Moore and Calvert (2000)), made new discoveries (see chapters 5-7) and learnt lessons (see chapter 3).

Further research must address the understanding of memory in ASD, and how it affects learning to read. Understanding these issues will advance the design standard instigated in this research. The empirical implementation of the design standard in post-doctorate research will bring the advantage of refining these standards.

Reference

Abowd, G. D. and Beale, R. (1991). Users, Systems and Interfaces: A Unifying Framework for Interaction. People and Computers VI, Cambridge University Press.

Adams, M.J (1996). Beginning to Read; Thinking and Learning about Print. England, MIT Press.

Advocate Newsletter of the Autism Society of America (2000). Reading Software for Individuals with Autism, Dimension Speech, Language and learning Services North. [Online]. Available from http://www.demensionspeech.com/articles-readingsoft.html [Accessed 1st October 2004].

Advocate Newsletter of the Autism Society of America (1996). Today's Technology Offers Optimism for Children with Autism to Live an Independent Life. [Online]. Available from http://www.dimensionspeech.com/article-techfuture.html [Accessed 4th July 2004].

Alcade, N. Marchena and Ruiz (1998). "Acquisition of Basic Concepts by Children with Intellectual Disabilities Using A Computer-Assisted Learning Approach." Psychological reports 82:1051-1056.

Alliance for Technology Access (2000). Computer and Web Resources for People with Disabilities: A Guide to Exploring Today's Assistive Technology. (3rd ed). Hunter House.

Allison, D. (1999). The Design of Children's Technology. San Francisco, Morgan Kaufmann.

Aman, M.G. (2004). "Management of Hyperactivity and Other Acting-out Problems in Patients with Autism Spectrum Disorder." Seminars in Paediatric Neurology 11(3):225-228.

Americans with Disabilities Act (1990). Americans with Disabilities Act of 1990, Wikipedia. [Online]. Available from http://en.wikipedia.org/wiki/Americans_with_Disabilities_Act_of_1990. [Accessed 23rd June 2009].

Ardehali, B. B. B. Furnham, A. Zakkar, M. and Williams, G. (2003). "A Pilot Investigating on Psychological Variable in Pre-and Post -renal First Attempt Transplant Patients." Transplantations medizin 15: 110-114. [Online]. Available from http://www.transplantation.de/fileadmin/transplantation/txmedizin/txmedizin_2003_2/ardehali.pdf [Accessed 23rd June 2009].

Armstrong, B. Glass, and Regan (1995). Reading Software for Student with Learning disabilities: Hypermedia-based Children's Literature, [LD Online Newsletter]. Available from http://www.ldonline.org/ld_indept/technology/lewis_rdgsftware.html [Accessed 30th April 2004]

Assistive Technology (2002). Assistive Technology, Assistive Technology. 2002. [Online]. Available from http://www.amug.org/~a203/astec.html [Accessed 16th January 2004].

Autism Independent UK (2008). What is Autism? [Online] Available from http://www.autismuk.com/index3.htm#demo [Accessed 3rd August 2008].

Autism Spectrum Australia (Aspect) (2002). Thinking and Learning in Autism. [Online]. Available from http://www.autismnsw.com.au/publications/Thinking%20and%20Learning%20in%20Autism.pdf#search=%22rote%20learning%20in%20autism%22 [Accessed 23rd June 2008].

Bakeman, R. and Gottman, J.M (1987). Applying Observational Methods: A Systematic View. Handbook of Infant Development. O. J. D. New York, John Wiley and Son Inc.

Bardill, A. (2003). The Development of Intelligent Hypermedia Courseware, for Design and Technology in the English National Curriculum at Key Stage 3, by the Sequential Combination of cognition clusters, Supported by Systems Intelligence, Derived from Dynamic User Model.(PhD), School of Lifelong Learning and Education, Middlesex University, London.

Baron-Cohen, S. (2007). Mind Reading: The Interactive Guide to Emotions [CD-Rom] Version 1.3, Jessica Kingsley Publishers.

Baron-Cohen, S. and Bolton, P. (1993). Autism: The Facts. Oxford, Oxford University Press.

Baron-Cohen, S. Leslie, A. M, Frith, U. (1985). "Does the Autistic Child have a 'Theory of Mind'?" Cognition 21: 37-46.

Barry, M. and Pitt, I. (2006). "Interaction Design: A Multidimensional Approach for Learners with Autism." IDC 2006. ACM. 33-36

Bartoli, J.S (1989). An Ecological Response to Coles's Alterative Interaction. Journal of Learning Disabilities. 22 (5): 292-297.

Bielby, N. (1994). Making Sense of Reading the New Phonics and its Practical Implications. England, Scholastic Publication.

Blaikie, N. (1993). Approaches to Social Enquiry. Cambridge, Blackwell.

Blank, M (1996). The Sentence Master: A Program for Success in Reading. [CD-ROM]. Laureate Learning Systems

Boden, M.A. (1988). Computer Models of Mind; Computational approaches in theoretical Psychology. Cambridge, Cambridge University Press.

Bondy, A and Frost, L. (2001). "The Picture Exchange Communication System." Behaviour Modification 25(5): 725-774.

Boone, H. Falba, and Langley (1993). Reading Software for Student with Learning Disabilities: Hypermedia-Based Children's Literature, [LD Online Newsletter]. Available from http://www.ldonline.org/ld_indept/technology/lewis_rdgsftware.html. [Accessed 30th April 2004]

Bright Tots: Educational Toys and Resource Guide to Child Development (2004). Hyperlexia Syndrome. Autism.[Accessed Online] http://www.brighttots.com/Hyperlexia.html [Accessed 26th June 2009]

Britannica (1988). Micropedia Ready Reference 1, A-ak Bayes.

BSI British Standards (2009). "British Standards".[Accessed Online]. Available from http://www.standardsuk.com/?gclid=COnG_PKEspkCFYND3god0jfS5Q . [Accessed 26th June 2009]

(CESA7), C. E. S. A. (2001). Autism Interventions and Strategies for Success, Wisconsin Department of Public Instruction through IDEA Discretionary Grant # 2000-9907-21.

Chen, S.H.A and Bernard-Opitz, V. (1993). "Comparison of Personal and Computer-Assisted Instruction for Children with Autism." American Association on Mental Retardation 31(6): 368-376.

Cockton, G. W. A. (2002). "Sale Must End: Should Discount Methods be clear off HCI's Shelves." Interactions 9(5):13-18.

Cohen, L. L. (2000). Research Methods in Education. London and New York, RoutledgeFalme.

Colby K.M (1973). "The Rational for Computer-based Treatment of Language Difficulties in Nonspeaking Autistic Children." Journal of Autism and Childhood Schizophrenia 3(3):254-260.

Colby, K.M and Smith, D.C. (1971). "Computer in the Treatment of Non Speaking Autistic Children." Current Psychiatric Therapies 11: 1-17.

Connor, M.J. (2004). Pupils with ASD: Teaching Approaches and Literacy. Surrey, the National Autistic Society (Surrey Branch) ".[Accessed Online]. Available from http://www.mugsy.org/connor51.htm [Accessed 26th May 2009]

Crane, L. G (2007). "Episodic and Semantic Autobiographical Memory in Adults with Autism Spectrum Disorder." Psy Quarterly (64).

Creswell, J. W. (1998). Research Design: Qualitative and Quantitative Approach. Thousand Oaks London New Delhi, Sage.

Creswell, J. W. (2003). Research design Qualitative, Quantitative and mixed methods Approaches. Thousand Oaks London New Delhi, Sage.

Damasio, A.R. and Maurer, R. G. (1978). "The Neurological Model for Childhood Autism." Archives of Neurology 35: 777 - 786.

Dawson, C. W. (2000). The Essence of Computing Project a Student's Guide. Harlow, Pearson.

Denscombe, M. (1998). The Good Research Guide for Small-Scale Research Projects. Buckingham, Philadelphia, Open University Press.

Denzin, N.K. and Lincoln, Y. S. (1998). Collecting and Interpreting Qualitative Materials. London, Sage publication.

Department for Education and Employment Qualification and Curriculum Authority (1999). The National Curriculum Handbook for Primary Teachers in England, Department for Education and Employment Qualification and Curriculum Authority. [Accessed Online]. Available from http://curriculum.qca.org.uk/ [Accessed April 20th 2009].

Deryn, W. (1987). Developing CAL: Computers in the Curriculum. London, Harper and Row.

DFES, Learning and Skills Improvement Service (2008). Adult Literacy Core Curriculum - Autistic Spectrum Disorder. [Accessed Online]. Available from http://www.excellencegateway.org.uk/sflcurriculum [Accessed April 20th 2009].

Dudley-Marling, C. (1995). "Whole Language: It's a Matter of Principles." Reading and Writing 11(1): 109-117.

Edelson S.M (a) (2008). Learning Styles and Autism, Autism Research Institute. [Accessed Online]. Available from http://www.autism.com/families/therapy/styles.htm [Accessed April 19th 2009].

Edelson S.M. (b) (2008). Understanding and Treating Self-Injurious Behavior, Autism Research Institute. [Accessed Online]. Available from http://www.autism.com/families/siblings/sib_org.htm [Accessed March 13th 2009].

Eisele J.E. (1980). "A Case for Computers in Instruction." Journal of Research and Developmental in Education 14(1):1-8.

Erickson and Staples (1995). Reading Software for Student with Learning Disabilities: Hypermedia-Based children's Literature, LD Online Newsletter. [Accessed Online]. Available from http://www.ldonline.org . [Accessed March 13th 2009].

Eysenck, M.W. and Keane M.T. (1995). Cognitive Psychology; A Student Handbook. Hove, Psychology Press.

Faulkner, C. (1998). The Essence of Human-Computer Interaction. Essex, Pearson Education.

Flick, U. (1998). An Introduction to Qualitative Research. London, Sage Publications.

Frith, U. (1972). "Cognitive Mechanism in Autism: Experiments with Color and Tone Sequence Production." Journal of Autism & Childhood Schizophrenia 2(2):160-173.

Frith, U. (1989). Autism Explaining the Enigma. Oxford, Basil Blackwell.

Frith, U. and Hill, E. L. (2003). Autism: Mind and Brain. Oxford, Oxford University Press.

Closing the Gap (2003). Computer Education can make a Difference for Children with Autism. . [Accessed March 13th 2009].

Goulden, K. (1998). Autism Today: Everything You Need to Know About Autism. A. Today, Autism Today.

Greig, A. and Taylor, J. (1999). Doing Research with Children. London, Sage Publication Ltd.

Gross, R.D. (1992). Psychology: The Science of Mind and Behaviour. London, Hodder & Stoughton.

Grynszpan, O, M. J., Nadel (2005). Human Computer Interface for Autism: Assessing the Influence of Task Assignment and output Modalities. Conference on Human Factors in Computing Systems CHI '2005, Oregon, USA, ACM New York, USA.

Gulliksen .J. and Harker, S. (2004). "The Software Accessibility of Human-Computer Interface - ISO Technical Specification 16071." UAIS 3: 6-16.

Hanna, U. Risden, K. and Alexander, K. J. (1997). Guidelines for Usability Testing with Children. Methods and Tools. [Online] Available from http://www.microsoft.com/usability/UEPostings/p9-hanna.pdf#search=%22Hanna%2C%20risden%20%26%20Alexander%20and%20Guidelines%20for%20Usability%22 [Accessed March 26th 2009].
.

Happe, F. (1999). "Autism: Cognitive Deficit or Cognitive Style." Trends in Cognitive Science 3(6): 216-222.

Happe. F (1996). Autism: An Introduction to Psychological Theory. London, UCL Press.

Hardy, C. Ogden, J. Newman, J. and Cooper, S. (2002). Autism and ICT: A Guide for Teachers and Parents, David Fulton Publishers.

Heimann, M. Tjus, T. Nelson, K.E. (a), (1993). Multimedia Facilitation of Communication Skills in Children with Various Handicaps, the DELTA Message Project. [Online] Available from http://spraakbanken.gu.se/personal/sofie/DELTA/Delta.html [Accessed March 26th 2009].

Heimann, M, Nelson, K. E. Gillberg, C. and Karnevik, M. (b), (1993). “Facilitating Language Skills through Interactive Micro-Computer Instructions: Observation on Seven Children with Autism." Scand Journal Log Phon 18: 3-8.

Heimann, M. Nelson, K. E. Tjus, T. and Gillberg, C. (1995). "Increasing Reading and Communication Skills in Children with Autism through an Interactive Multimedia Computer Program." Journal of Autism and Development Disorder vol. 25(5):461-480.

Henninger, S. Haynes, K. and Reith, M.W (1995). A Framework for Developing Experience - Based Usability Guidelines. Designing Interactive Systems: Process, Practices Methods, & Techniques, Michigan , USA, ACM, New York, USA.

HERO: The Official Online Gateway to Higher Education and Research in the UK (2008). Intervening in Autism. [Online] Available from http://www.hero.ac.uk/uk/research/archives/2002/intervening_in_autism2229.cfm [Accessed May 4th 2009].

Hetzroni, O.E and Tannous, J. (2004). "Effects of a Computer-Based Intervention Program on the Communicative Functions of Children with Autism." Journal of Autism & Developmental Disorder 34(2):95-113.

High / Scope Educational Research Foundation (2008). Curriculum, High / Scope Educational Research Foundation. [Online]. Available from https://secure.highscope.org/Content.asp?ContentId=1 [Accessed March 26th 2009].

Hill, E.L. Frith, U. (2003). Understanding Autism: Insights from Mind and Brain. Autism: Mind and Brain. Frith. U and Hill E.L. Oxford, Oxford University Press.1-19

Hill, E. L. (2004). "Executive Dysfunction in Autism." Trends in Cognitive Science 8(1): 26-32.

Hudson, K. (1984). Introducing CAL; A Practical Guide to Writing Computer-Assisted Learning Programme. England, Chaucer Press.

Inclusive Technology (2008). Information Communication Technology (ICT) and Autism. Delph. Oldham, UK, Inclusive Technology. [Online] Available from http://www.inclusive.co.uk/infosite/autisms.html. [Accessed March 26th 2009].

Ivory, M.Y and Hearst, M.A (2001). "The State of the Arts in Automating Usability Evaluation." ACM Computing Surveys. 33(4).

Institute of Electrical and Electronics Engineers (IEEE), (2009). IEEE Standards Association. [Online] Available from http://www.ieee.org/web/standards/home/index.html [Accessed March 26th 2009].

Johnson, C.P, Myer, S.M and the Council for Children with Disabilities (2007). "Identification and Evaluation of Children with Autism Spectrum Disorder." Paediatrics 120(5):1183-1215.

Jordan,.R and Glenys, J. (1999). "Review of Research into Educational Intervention for Children with Autism in the UK." Autism 3(1):101-110.

Jordan, R. and Powell, S. (1990). "Teaching Autistic Children to Think More Effectively." Communication 24(1):20-23.

Kichenham, B.A. Pfleeger, S. L. Pickard, L.M. Jones, P.W. Hoaglin, D.C. El Emam, K. and Rosenberg J (2002). "Preliminary Guidelines for Empirical Research in Software Engineering." IEEE Transactions on Software Engineering 28(8):721- 733.

Kindersley, D. (1998). Multimedia the Complete user-friendly Guide to the Internet, World Wide Web, DVDs, Virtual Reality, CD-ROMS and 3D Games. London, Dorling Kindersley.

Koltringer,T. Tomitsch,M. Kappel, K. and Grechenig,T . (2006). Guidelines for Designing Useable DVD Menus. 20th BCS HCI Group Conference in Co-operation with ACM, Queen Mary University London.75-78

Kuutti, K. (1995). Activity Theory as a Potential Framework for Human Computer Interaction Research. Cambridge, MIT Press.

Lacava, P.G. Golan, O. Baron-Cohen, S. and Myles, B.S. (2007). "Using Assistive Technology to Teach Emotion Recognition to Students with Asperger Syndrome." Remedial and Special Education 28(3): 174-181.

Lau, F.K. Yuen, H.K. and Lian, M.G. (2006). Enhancing Spoken Vocabulary Performance in Children with Autism in a Multimedia-Supported Context. [Online] Available from http://hub.hku.hk/bitstream/123456789/44053/1/content.pdf [Accessed 15th March 2009] .

LD Online Newsletter (2002). Reading Software for Student with Learning Disabilities: Hypermedia-Based Children's Literature. [Online].Available from http://www.ldonline.org/indepth/technology [Accessed 15th March 2009] .

Lewis, R.B (2000). Project LITT (Literacy Instruction through Technology): Enhancing the Reading Skills of Students with Learning Disabilities through Hypermedia-Based Children's Literature. Final Report, Eric Education Resources Information Center. Online].Available from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/13/66.pdf [Accessed 15th March 2009] .

Lovaas O.I, F. L., Nelson.K, & Whalen.C, (1967). "The Establishment of Imitation and its Use for the Development of Complex Behaviuor in Schizophrenic Children." Behaviour Research and Therapy 5:171-181.

Laureate Learning Systems(2001). The Sentence Master: A Program for Success in Reading. (Computer Software). (Winooski, Special Needs Educational software, 2000).

Martin, M. Claydon, E. Morton, A. and Binns, S. (2003). "The Development of Orthographic and Phonological strategies for the Decoding of Words in Children." Journal of Research in Reading 26(2): 191-204.

Mayer, R.E. (2001). Multimedia Learning. New York, Cambridge University Press.

Mesibov, G.B (1998). Learning Styles of Students with Autism. SESA -Fall '98 Reference Shelf-Autism. SESA.

Microsoft (1999). Microsoft Computer Dictionary. Washington, Microsoft Press.

Moore, D. McGrath, P. and Thorpe, J .(2000). "Computer-Aided Learning for People with Autism- a Framework for Research and Development." Innovations in Education and Training International 37:3: 218-228.

Moore, M. and Calvert, S. (2000). "Brief Report: Vocabulary Acquisition for Children with Autism: Teacher or Computer Instruction." Journal of Autism & Developmental Disorder 30:359 - 362.

Morris, P.E. and Fritz, C.O (2000). "The Name Game: Using Retrieval Practice to Improve The Learning of Names." Journal of Experimental Psychology 6(2):124-129.

Moseley, R. (2005). Self-Adaptation and Reflection in Dynamic Reconfigurable Systems. In R. Adams. 'Natural Computing and Interactive System Design '.Essex, Pearson Custom Publishing.69-89.

Murray, D.K.C (1997). Autism and Information Technology: Therapy with Computers. Autism and Learning; A Guide to Good Practice. S. a. J. R. Powell. London, David Fulton Publishers.

Nardi, B. (1996). Activity theory and HCI & Studying Context. Context and Consciousness: Activity theory and human computer interaction. B. N. (Ed). Cambridge, MIT Press.

National Autistic Society (2007). Statistics: How Many People Have Autistic Spectrum Disorders?. [Online]. Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=235&a=3527 [Accessed 11th January 2009].

National Autistic Society (2008a). Autism: What is it? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=211 [Accessed 11th January 2009].

National Autistic Society (2008b). The Sensory World of the Autism Spectrum. [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?=299&a=3766 [Accessed 11th January 2009].

National Autistic Society (2008c). What is the SPELL Framework? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=297&a=3362 [Accessed 11th January 2009] .

National Autistic Society (2008d). What is TEACCH? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=297&a=3630 [Accessed 11th January 2009].

National Autistic Society (2008e). What is Lovaas Method? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=297&a=3345 [Accessed 11th January 2009] .

National Autistic Society (2008f). Computer Application for People with Autism. [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d108&a=3276 [Accessed 13th January 2009].

National Autistic Society (2008g). Picture Symbols: for Professionals and Students. London, National Autistic Society. [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?=297&a=3642 [Accessed 15th January 2009].

National Autistic Society (2008h). Applied Behavioural Analysis (ABA). [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=1390&a=15100 [Accessed 11th January 2009] .

National Institute of Mental Health (2004). Autism Spectrum Disorders Research at the National Institute of Mental Health. [Online] Available from http://www.nimh.nih.gov/pubicat/autismresfact.cfm [Accessed 11th January 2009].

Nelson, K.E, Heimann M. and Tjus T, (1997). Theoretical and Applied Insight from Multimedia Facilitation of Communication Skills in Children with Autism, Deaf Children, and Children with Other Disabilities. In Adamson L.B and Romski M.A, (eds.). Communication and Language Acquisition Discoveries from a Typical Development. Brookes.295-323

Nelson, K.E. Welsh, J.M. Camarata, S.M. Tjus, T. and Heimann M. (2001). A Rare Event Transactional Model of Tricky Mix Conditions Contributing to Language Acquisition and Varied Communicative Delays. In. Nelson, K.E, Koc, A, Johnson C (eds.) Children's Language. Hill Dale. 165-195

Glam Publisher (2008). Teaching Autistic Children Reading. [Online] Available from http://kids.lovetoknow.com/wiki/Teaching_Autistic_Children_Reading [Accessed 10th April 2009].

Newson. E (2001). Using Humour to Enable Flexibility and Social Empathy in Children with Asperger's Syndrome: Some Practical Strategies. Helping Children with Autism to Learn. In S. Powell. London (ed.). David Fulton publishers.

Nielsen and Molich (1990). How to Conduct a Heuristic Evaluation. [Online] Available from http://www.useit.com/papers/heuristic/heuristic_evaluation.html [Accessed 11th January 2009].

Nielsen, J. and Mack, R.L, (1994). Usability Inspection Methods. New York, John Wiley & Sons.

Nind, M. (2001). Intensive Interaction and Children with Autism. In S. Powell (ed). Helping Children with Autism to Learn. London, David Fulton publishers.

Norman, D. A (1988). The Psychology of Everyday Things. New York, Basic Books.

Office of Public Sector Information (1995). United Kingdom Disability Discrimination Act. [Online]. Available from http://www.opsi.gov.uk/acts/acts1995/ukpga_19950050_en_5#pt4-l1g29 [Accessed 11th January 2009].

Oliver, P. (1997). Research for Business, Marketing and Education, Hodder Stoughton.

Paivio, A. (1971). Imagery and Verbal Processes. New York, Holt, Rinehart and Winston.

Panyan, M .V (1984). Computer Technology for Autistic Students. Journal of Autism and Developmental Disorders, 14, No. 4:375-382.

Parents let's Unite for Kids (PLUK), (1998). Family Guide to Assistive Technology. [Online] .Available from http://www.pluk.org/AT1.html. [Accessed 26th June 2009].

Pavlov, I.P (1927). Conditioned Reflexes: An Investigation of the Physiological Activity of the Cerebral Cortex. Classics in the History of Psychology. Developed by Christopher D. Green. [Online] .Available from http://psychclassics.yorku.ca/Pavlov/ [Accessed 4th June 2009].

Peeters, T. (2001). The Language of Objects. Helping Children with Autism to Learn. In S. Powell (ed.). London, David Fulton publishers.

Persaud, N. (2000). Labelling: Its Effects on Labelled Students. Ontario, International Special Education Congress 2000. [Online] .Available from http://www.isec2000.org.uk/abstracts/papers_p/persaud_1.htm. [Accessed 4th June 2009].

Potter, S. (2002). Doing Postgraduate Research. London, Sage Publications.

Powell .S and Jordan .R (1997). Rationale for the Approach. Autism and Learning; A Guide to Good Practice. In S. Powell, and R. Jordan R, (eds.). London, David Fulton Publishers.

Powell, S. (2001). Learning About Life Asocially: The Autistic Perspective on Education. Helping Children with Autism to Learn. In S. Powell (ed.). London, David Fulton publishers: 1-13.

Preece, J. (1993). A Guide to Usability Human Factors in Computing, Addison-Wesley.

Preece, J. Rogers, Y. Sharp, H. Benyon, D. Holland, S. Carey, T. (1994). Human -Computer-Interaction. Essex, Addison-Wesley.

Qualification and Curriculum Authority (2001). Planning, Teaching and Assessing the Curriculum for pupils with learning Disabilities; English. London.

Rannou, Y. (2002). Testing Educational Software with Children. Testing Educational Software with Children, STC Usability SIG. [Online] .Available from http://www.stcsig.org/usability/newsletter/0201_testingeducational.html [Accessed 14th May 2009].

Raskind .M (2000). Assistive Technology for Children with Learning Disabilities, Schwab Foundation for Learning. [Online] .Available from http://www.pluk.org/Pubs/ATguide4LD_419k.pdf [Accessed 3rd May 2009].

Robins, B. Dautenhahn, K., Boekhorst, T. E. Billard, A. (2005). "Robotic Assistants in Therapy and Education of Children with Autism: Can a Small Humanoid Help Encourage Social Interaction Skills?" Universal access in HCI inclusive Design in the Information society (UAIS). 4 (2):105 - 120

Robinson, D. and Reed, V. (1998). The A-Z of Social Research Jargon. Aldershot, Ashgate publishing.

Robson, C (2002). Real World Research. Oxford, Blackwell.

Rohrer, D. Taylor, K. Pashler, H. Wixted, J.T. Cepeda, N. (2005). "The Effect of Overlearning on Long-Term Retention." Applied Cognitive Psychology 19:361-374.

Russell, J. Hala, S. Hill, E. (2003). "The Automated Windows Task: the Performance of Pre School Children with Autism, and Children with Moderate Learning Difficulties." Cognitive Development 18:111-13

Saffran, R. (1998). Curriculum Outline for Behavioural Intervention Program for a Young Child. [Online] .Available from http://rsaffran.tripod.com/whatisaba.html [Accessed 3rd May 2009].

Sauro, J. (2004). "Premium Usability: Getting the Discount without Paying the Price." Interactions 11(4): 30-37.

Shapiro, P. (2002). How Apple II Computers are Helping Autistic Children. [Online] .Available from http://www.his.com/~pshapiro/autism.and.computers.html [Accessed 4th June 2009].

Siegel, B. (2003). Helping Children with Autism Learn; Treatment Approaches for Parents and Professionals. New York, Oxford University press.

Silverman, D. (2005). Doing Qualitative Research. London, Sage.

Simpson, R.L. (2001). "ABA and Students with Autism Spectrum Disorder: Issues and Considerations for Effective Practice." Focus On Autism and Other Developmental Disabilities 16(2):68-71.

Sindelar (1987). Reading Software for Student with Learning Disabilities: Hypermedia-based Children's Literature. LD Online Newsletter. [Online] .Available from http://www.ldonline.org/ld_indept/technology/lewis_rdgsftware.html [Accessed 3rd May 2009].

Somervell, J. and McCrickard, D. S (2005). "Better Discount Evaluation Illustrating How Critical Parametre Support Heuristic Creation." Interacting with Computer 17(5):592-612.

Stewart, R. (2002). Motivating Students Who Have Autism Spectrum Disorder. [Online] .Available from http://www.bbbautism.com/pdf/article_34_motivativating_people_with_ASD.pdf [Accessed 13th May 2009].

Stokes.S (2009). Assistive Technology for Children with Autism. Autism: Interventions and Strategies for Success, CESA7. [Online] .Available from http://www.specialed.us/autism/assist/asst10.htm [Accessed 12th May 2009].

Strong, G.W. (1995). "New Directions in Human -Computer Interaction: Education, Research, and Practice." Interactions 2(1): 69-81.

Strydom J. and Plessis, S.D (2002). Overcoming Learning Disorder: Building a "Pyramid of Repetition". Repetition in Learning. Audiblox. Learning and learning Disabilities Online. [Online] .Available from http://www.audiblox2000.com/learning_disabilities/overcoming_learning_disabilities2.htm [Accessed 12th September 2008].

Suh, K. Couchman, P.K. Park, J. Hasan, H. (2003). "The Application of Activity Theory to Web-Mediated Communication." Information Systems and Activity Theory. [Online] .Available from http://www.syros.aegean.gr/users/tsp/citations_dnl/ATIS3_Chapter6.pdf [Accessed 12th September 2008].

Sutherland, P. (1992). Cognitive Development Today. London, Sage Publication.

Swenson R.P and Kingman J.C (1981). Computer-Assisted Instruction in Special Education. Proceeding of the John Hopkins 1st National Search for Applications of Personal Computing to Aid Handicapped, IEEE.76-77

Taylor, J. B. (1996). "Piagetian Perspectives on Understanding Children's Understanding." Childhood Education. 72 (5) 311-13.

Reb Tool (2004). What's Assistive Technology. Assistive Technology, Reb Tools. [Online] .Available from http://www.rehabtool.com/at.html [Accessed 12th September 2008].

Technology-Related Assistance for individual with Disabilities Act of 1988 (1988). Technology-Related Assistance for individual with Disabilities Act of 1988 (Public Law 100-407). [Online] .Available from http://www.handinet.org/tech_act.htm [Accessed 12th September 2008].

Temple G. (2002). Teaching Tips for Children and Adults with Autism, Autism Research Institute. [Online] .Available from http://www.autism.com/families/therapy/teaching_tips.htm [Accessed 12th September 2008].

Tetzlaff, L. and Schwartz, D. R (1991). The Use of Guidelines in Interface Design. SIGCHI Conference on Human Factors in Computing Systems: Reaching Through Technology, New Orleans, Louisiana, United States.329 - 333

The Comite Europeen de Normalisation (CEN) (2003). Guidelines to Standardisers of ICT Products and Services in the CEN ICT Domain. [Online] .Available from http://www.cen.eu/cenorm/sectors/sectors/isss/index.asp [Accessed 4th June 2009].

Herskowitz, V. (2000). Computer-Based Therapy for Individuals with Autism. The National's Speech-Language and Audiology Weekly. [Online] .Available from http://www.dimensionsspeech.com/articles.shtml [Accessed 12th September 2009].

Thompson, B. (1979). Reading Success a Guide for Parents and Teachers. London, Sidgwick and Jackson.
Thornes, N. (2008). Reading. [Online] .Available from http://www.nelsonthornes.com/wps/portal/!ut/p/c1/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gDA2NPI2czU3Mng0APY-NAHzcDKADKR2LKu1jC5fHrDgfZh18_RB47cDTQ9_PIz03VL8iNMMgycVQEAABVwZ8!/dl2/d1/L2dJQSEvUUt3QS9ZQnB3LzZfMDAzSTJDNjU3QjBRSDMzUU42MTAwMDAwMDA!/ [Accessed 12th September 2008].

Tjus, T. Heimann, M. and Nelson, K. (1998). "Gains in Literacy Through the use of Specially Developed Multimedia Computer Strategy." Sage publications 2 (2):139 - 156.

Tjus, T. Heimann, M. and Nelson K (2001a). "Interaction Pattern between Children and their Teachers When Using a Specific Multimedia and Communication Strategy." Autism 5(2):175-187.

Tjus.T, and Heimann M. (2001b). Language, Multimedia and Communication for Children with Autism Searching for the Right Combination. Helping Children with Autism to Learn. In S. Powell (ed.). London, David Fulton publishers.78-93

Topologika Ltd (Computer Software). Speaking for Myself. (Cornwall, Topologika Educational software, 1994).

Trehin P. (1994). Computer Technology and Autism, LINK Autism-Europe. 2008. {Online}. Available from http://www.autism-resources.com/papers/LINK.htm [Accessed 12th September 2008].

Trevarthen, C. Aitken, K. Popoudi, D. Robarts, J. (1998). Children with Autism Diagnosis and Interventions to Meet Their Needs. London and Philadelphia, Jessica Kingsley Publishers.

Tuedor M. (2006) .Guidelines to Selecting Appropriate Literacy Educational Computer Programs for Children with Autism Conference 2006,Technology and Persons With Disabilities Conference, Los Angeles, CA.

Vacca, J.S (2007). "Autistic Children Can be taught to Read." International Journal of Special Education 22(3):54-61.

Wall, J. (2004). The Role of E-Learning – A Review. [Online]. Available from http://www.multimedia-instruction.com/Docs/THE%20ROLE%20OF%20E-learning.doc [Access on 18th June 2009]

Web Accessibility Initiative (WAI) (1999). Web Content Accessibility Guidelines 1.0. [Online]. Available from http://www.w3.org/TR/WCAG10/#organization [Access on 18th June 2009]

Webster (2001). Webster's New World Computer Dictionary. 9th ed. New York, Hungry Minds.

Wikipedia (2008). Learning. [Online]. Available from http://en.wikipedia.org/wiki/Learning [Access on 15th June 2009]

Wikipedia (2008). Whole Language. [Online]. Available from http://en.wikipedia.org/wiki/Whole_language [Access on 15th June 2009]

Williams C. Callaghan, B. and Coughlan. B. (2002). "Do Children with Autism Learn to Read More Readily by Computer Assisted Instruction or Traditional Book Methods?" Sage Publication and the National Autistic Society. 6(1) p. 71-91.

Wing, L. (1996). The Autistic Spectrum. London. Constable Press.

APPENDICES

APPENDIX A 1

APPENDIX B 3

APPENDIX C 4

APPENDIX D 6

APPENDIX E 14

APPENDIX F 17

APPENDIX G 20

APPENDIX H 21

APPENDIX I 42

APPENDIX J 44

APPENDIX K 47

APPENDIX L 48

APPENDIX M 51

APPENDIX N 54

APPENDIX O 55

APPENDIX P 65

APPENDIX Q 71

APPENDIX R 77

Appendix A

Middlesex University
Trent Park Campus
IDC
Repton building
Bramley Road
N14 4YZ
01/07/2003

Woodfield School
Malmes Croft
Leverstock Green
Hemel Hampstead
Herts HP 3 8RL.

Dear Sir/ Madam,

Permission to carry out research at your school

I am a Ph.D. student at Middlesex University and would like to be granted permission to conduct an evaluative study at your school. This study would be used as part of my Ph.D. research into the usability of educational computer programs as a re-enforcing tool, used in the classroom for helping children with Autistic Syndrome Disorder (ASD) aged 5-10 to develop early reading skills. This research would involve conducting an evaluation, which would include interviews, observation and the completing of questionnaires.

We all know that reading is a vital skill in everyday life, but, for people with ASD, developing this skill can prove difficult because of the problems that are associated with this disability, including perception problems, attention problems, motivation problems, etc. Being a mother of a seven-year-old boy with ASD and severe learning difficulties, I have first-hand experience of some of the difficulties faced by children and adults with autism and learning difficulties in developing early reading skills.

Research has shown that children with ASD are responsive to multimedia communicative learning opportunities. The use of educational computer programmes has been proven to enhance the learning of children with ASD and other learning disabilities.

This research would be of great benefit to the children at your school and a lot of other children with ASD and children with learning disabilities. It would combine the use of proven teaching methodologies (such as Teacch) and reading methods (such as the whole language approach and the look-and-say approach) and the use of computer technology in helping children with ASD and other children with learning disabilities to develop early reading skills. Conversely, it would involve evaluating the content, design and development of educational computer programs.

Your contribution to this research is vital. As educators of children with ASD and learning disabilities, your knowledge of the needs of these children would be of enormous benefit to this study.

To preserve the anonymity of the school, the privacy of the participants in this study and to respect the sensitivity of the research, the findings will be used only in the context of this study.

Thank you for taking time out of your busy schedule to reply to this letter and for your anticipated cooperation.

Yours sincerely,

Marian Tuedor

Appendix B

Middlesex University
Trent Park Campus
IDC
Repton building
Bramley Road
N14 4YZ

Consent letter to research participants

Dear evaluators/participants,

Thanks for your interest in this study. This research will be used as part of my Ph.D. research on the usability of Educational computer programs as a re-enforcing tool used in promoting literacy (early reading skills) in children with Autistic Spectrum Disorder (ASD). This research will involve conducting an evaluation, which will include questionnaires and interviews.

I value your participation in this study, your contributions and your time. In order to preserve your anonymity and the privacy of the participants in this study and to respect the sensitivity of the research, the findings of this research will be used only in the context of this study.

Thanks for you assistance.

Yours faithfully

Marian Tuedor

Appendix C

List of Educational Computer Programs Identified
The educational computer programs selected in this investigation were completed firstly on the basis of two criteria (see below), as well as the Selection Instruction (SI) (see appendix D).

Information about the programs identified:

Name of the program	*Manufacturer*	*Type of program:*	Type	I or E
1. Away we go	Scientific learning corporation	Reading (phonological awareness decoding skills)	ER	E
2. Reading edge	Scientific learning corporation	Games & evaluation of phonological awareness	EG	E
3. Wellington square	Semerc	Reading	ER	E
4. Sound start	Semerc	Reading (phonics)	ER	E
5. Scally's word of verbs	Topologika	Reading	ER	E
6. Tiger tale	Laureate	Language and literacy skills	ER	E
7. Swim swam swum	Laureate	Reading and spelling	ER	E
8. First Noun	Laureate	Reading (nouns)	ER	E
9. First Verb	Laureate	Reading (verbs)	ER	E
10. First Word	Laureate	Reading (nouns)	ER	E
11. Sentence Master	Laureate	Reading and spelling	ER	I
12. Stories and more	Edmark	Reading and comprehension	ER	E
13. Speaking for myself	Topologika	Reading and speech	I	I
14. Sound it out land	V99	Teach phonic skills utilizing music	ER	E
15. Literacy	Fundamentals (previously LocuTour)	Reading and spelling	ER	E
16. Let's go read	Edmark	Reading (letters & sound) comprehension	ER	E
17. Bailey's book house	Edmark	Develop listening skills, comprehension & categorisation skills	ER	E

Name of the program	*Manufacturer*	*Type of program:*	*I or E*	*I or E*
18. Sherlock	Topologika	Develop comprehension, spelling, vocabulary, concentration and predicting reading skills.	ER	E
19. Text thing	Topologika	Focuses on key literacy skills to improve spelling, punctuation, reading and letter and word recognition	ER	E
20. Clicker 4	Crick Software	Writing, teaching and communication	O	E

Measures used for selection or elimination of the programs

Measure A (underling reading methods and objectives)
Measure B (simple aesthetic and usability)

The overall suitability of the program for children with Autistic Spectrum Disorder (ASD); based on the researcher's expert knowledge and literature on this subject.

Explanation of the initial used in the investigation

Types of program:
TD = Tutorial drill and practice
DP = Drill and practice
PS = Problem solving
S= Simulation
EG= Educational games
ER= Educational reading program
O= Other

Included or excluded from the study
I= Included in study
E= Excluded from study

Appendix D

Middlesex University

Selection Instruction (SI)

Selection Instruction (SI) intended for facilitating the choosing of suitable educational computer programs to support early reading in children with Autistic Spectrum Disorder (ASD).

General Information

This document details set instructions to facilitate the selection of suitable early reading educational computer programs for ASD children. The set of instructions proposed was employed as a preliminary investigation in a research Middlesex University School of Engineering and Information Sciences research into the standardizing computer program for children with ASD.

The questionnaire are based on 36 questions (which is based on 5 criteria). Each criterion addresses crucial aspects of ASD and severe learning disabilities that should be adequately addressed by any suitable educational program that is designed for these children.

These guidelines can be employed by researchers, professionals working with ASD children and the parents or guardians of children with ASD seeking assistance in the selection of appropriate educational computer programs.

Areas addressed (criteria)

The criteria are:

- Aims of using technology and learning objectives
- Program content and usability
- Skills of the user and learning style
- Psychological issues
- Communication issues and assistive technology

There were a total of 36 questions:

Http://www.csun.edu/cod/conf/2006/proceedings/2802.htm

<u>Evaluation Instruction Questionnaire</u>

General information about the program reviewed

Name of the program:

Developers of the program:

Computer platform (Microsoft or Mac):

Purpose of the program:

Skills required for using the program:

Special needs issues addressed by the program.

Criterion 1 (Aims of employing technology and learning objectives)

Question	***Responses(yes/no)***	***Commentary***
Aims 1. Does the program state what sort of program it is?		Refer to the additional information section of this document for the listing and explanation of the various types of computer program
2. Does the program state the pedagogical and teaching style employed in the program?		Refer to the additional information part of this document for the various teaching style in various types of computer program

Recommendations

- *Have clearly stated reasons about "why computer technology is needed to be added to the repertoire of learning tools" for the user.*
- *Identifying the learning objectives of the program and comparing these with the user learning objectives (this can be based on the annual learning objective[1] of the user).*

Write your comments here

[1] This could be the users' statement of their special needs, or the learning target as stipulated by the teacher.

Criterion 2 Program content and usability (interface design)

Program content and instruction

Question	***Responses(yes/no)***	***Commentary***
3. Easy to read Is the program easy to read (uncluttered, content legible, menu items easy to understand)?		
4. Intuitive characteristics Is the program intuitive to use?		The program should be easy to predict and follow a logical sequence.
5. Logical labels Are the labels (choice of selection) used in the program logical and easily understandable?		
6. Graphic Do the computer graphics used in the program provide learning at an appropriate level for the intended user?		Computer programs can employ graphics at an intuitive level (a level that makes it easy for the user to understand what they mean or represent), enabling users easily to understand what is being taught.
7. On-screen instruction Does the program have on screen instructions, such as pop-up menus to guide the user through using the program?		
8. Audio prompts and clues Does the program use audio prompts and clues, such as pop-up messages?		
9. Visual prompts and clues Does the program use visual prompts to support the audio prompts provided in the program?		Visual prompts, such as cursors, can point the user to the next task at hand.

Customisation

10. Is the program customisable to suit individual users?		
11. Does the program make provision for the recording of the user' performance on the program?		

Usability questions

12. Platform and operating system Is the program supported by the user's operating system (for example, if users have a Windows operating system, does the program support this platform)?		

13. Visibility of system status Does the program keep the user informed about what is going on, through appropriate feedback within a reasonable time?		
14. User control and freedom Does the program provide an emergency exit for the user to leave an unwanted state without having to go through an extended dialogue?		
15. Flexibility and efficiency of use Does the program provide the flexibility for the program to be customised to suit individual user?		
16. Aesthetic and minimal design Is the program pleasing for the user to look at (aesthetic)?		
17. Recognition, diagnosis and recovery from error Does the program explain errors in a clear and precise way that is understood by the user, when the program malfunctions?		
18. Accuracy demands Does the program give flexibility for inaccurate or random clicking by users?		As the users are autistic, the system should be able to accommodate random clicking without crashing.
19. Feedback about accuracy Does the program give feedback if the response given by the user is accurate or inaccurate?		
20. The response time Is the response time demanded by the program at the correct level for the user?		

Write your comments here

Criteria 3 Skills of users and learning style

Question	***Responses(yes/no)***	***Commentary***
21. Content of the program Are the subjects or topics taught by the program at the appropriate academic level for the user?		
22. Reinforcement and motivation techniques Are the techniques of reinforcement and motivation provided by the system on a timely basis?		Children with autism and SLD have problems with motivation; an appropriate program should have timely motivation prompts to help alleviate some of these problems.
23. Attention skills Does the program promote attention at an appropriate level for the user?		For example, having timely animations can help to sustain the user's attention.
24. Learning style of the user Does the information on the program cater for the learning style of the user (for example, if the user is a visual learner, the use of symbols or photographs may support learning)?		Refer to the addition information section of this document for more detail on autistic learning style.

Write your comments here

Criteria 4 Psychological issues (inference and generalisation)

Source: Simplex 2

Question	***Responses(yes/no)***	***Commentary***
25. Are the activities that the program tries to teach too complex?		The information provided should be minimal
26. Does the program provide adequate visual and auditory information to assist the user in learning new concepts?		The computer should promote inference and generalisation skills in the user.
27 .Does the computer program provide adequate feedback?		

Question	***Responses(yes/no)***	***Commentary***
28: Does the program require a large amount of prior knowledge to use the system?		The computer program should help to alleviate memory problems in the autistic user rather than compound them.
29. Does the program use a familiar model (symbols, photo of objects or concepts) that the users can understand?		Using familiar models will promote generalisations and inferential skills.
30. Does the program aid the child's inability to recognize structures?		The program should be structured and consistent.
31. Does the program reduce the amount of information that the child has to remember?		Promoting memorising skills in the users
32. Does the program integrate new items taught into pre-existing items known?		Promoting generalisations and memory problems in autism.

Criteria 5 (communication and assistive technology)

Question	***Responses(yes/no)***	***Commentary***
33. Optional Cursor Does the program provide an alternate cursor?		Some users with autism may respond better to a cursor which is a familiar object.
34. Appropriate level of communication Does the program provide alternate communication support for non-verbal users (such as sign language, pictures or symbols)?		
35. Assistive technology (input devises) Does the program support assistive input devices (for example, touch screens, switches and joysticks)?		
Assistive technology (output devises) 36. Does the program support assistive output devices (for example, screen readers, screen enlargement)?		

Write your comments here

Applying the guidelines
The reviewer has carefully to review each question with a YES or NO response. The total score for each criterion has to be a total for half the questions with a "YES" response for each section.

The reviewers have to apply their discretion in employing this questionnaire, these guidelines should in conjunction with the reviewer's understanding of the subjects; as they know, and the child for which the computer program is aimed for should always in at the fore front of the reviews mind whilst using this questionnaire (as it is only serve as a guide).

Additional Information
Computing Jargon (Categories of Educational Computer Programs)

Computer Aided (or Computer Assisted) Instruction (CAI)
An acronym for Computer Aided (or Computer Assisted) Instruction, CAI, are educational programs that are designed to serve as a teaching tool (Microsoft, 1999). CAI is usually used in tutorials, drills and question-and-answer sessions which are designed to test the user's comprehension. CAI systems are often used for presenting materials and for allowing users to pace their speed whilst learning. CAI is also known as CAL, computer aided teaching or computer assisted teaching (CAT).

Computer Based Learning and Computer Aided (or computer assisted) Learning (CBL) and (CAL)
This is an acronym for computer based learning. It is commonly used with reference to CAI which focuses primarily on education or computer based training (CBT). An acronym for computer aided (or computer assisted) learning. A general definition for CAL is that it is a method of presenting educational material to a learner by means of computer programs which also gives the opportunity for individual interaction.

Multimedia program

Multimedia is a computer-based method of presenting information by using more than one medium of communication, such as graphics, sound and emphasising interactivity. Multimedia may enable a user to have access to information; hypermedia enables the user to interact with the system.

Hypermedia program

The way in which a multimedia system enables you to interact with particular programs is made possible by the use of hypertext. Hypertext is a body of text where some or all of the information is linked; so that when a user clicks on a word, you can obtain more about the word or be transported to another section of the document that contains related information. Hypermedia programs employ multimedia resources (graphics, video, animation and sound) in the production of an interactive technology.

Pedagogical Style

Tutorial drill and practice (TDP/ DP)
A program is a sequence of instructions that can be executed by a computer. An instructional program that takes users through a predetermine sequence or steps in order to learn a product. This could be presented as a series of lessons in an interactive format (form of a disk or CD-Rom)

Problem solving program (PS)

In this type of computer program a strategy is implemented, whereby a less desirable condition is changed to a more desirable one using the computer program.

Simulation program (S)
It is computer program that imitates real life situations, physical processes or objects by the computer. For example, a program could be designed to respond mathematically to data.

Educational games (EG)
Educational games are classes of computer programs, where one or more users interact with the computer as a form of entertainment with the element of learning and educational objectives.

Reading programs or educational reading programs (RP/ERP)
Educational reading programs are computer programs designed to promote literacy using the computer.

Reference

Adams, R and Langdon, P. (2003). "Simplex : simple user check-model for inclusive design." Universal access in HCI inclusive design in the information society: p.13-17.

Alliance for Technology Access (2000). Computer and Web Resources for People with Disabilities: A Guide to Exploring Today's Assistive Technology. (3rd ed). Hunter House.

Nelson, K.E, Heimann M. and Tjus T, (1997). Theoretical and Applied Insight from Multimedia Facilitation of Communication Skills in Children with Autism, Deaf Children, and Children with Other Disabilities. In Adamson L.B and Romski M.A, (eds.). Communication and Language Acquisition Discoveries from a Typical Development. Brookes.

Nelson, K.E. Welsh, J.M. Camarata, S.M. Tjus, T. and Heimann M. (2001). A Rare Event Transactional Model of Tricky Mix Conditions Contributing to Language Acquisition and Varied Communicative Delays. In K. A. Nelson K.E, Johnson C (eds.) Children's Language. Hill Dale.

Nielsen, J. a. M. R. (1990). Heuristic Evaluation of User Interface. Conference on Human Factors in Computing Systems archive. Proceedings of the SIGCHI conference on Human factors in computing systems: Empowering people, Seattle, Washington, United States, ACM Press. New York, USA.

Nielsen, J. and Mack, R.L, (1994). Usability Inspection Methods. New York, John Wiley & Sons.

Parents let's Unite for Kids (PLUK), (1998). Family Guide to Assistive Technology. [Accessed Online] http://www.pluk.org/AT1.html. [Accessed 26th June 2009].

Middlesex University

Appendix E

Educational computer program attitude questionnaire
(Autistic Spectrum Disorder (ASD) educationalists)

Name of program been evaluated:

Evaluator ID:

The purpose of this exercise is to evaluate the educational computer program listed above. Please tick one responds for each statement.

Statements	***strongly agree***	***agree***	***disagree***	***strongly disagree***
System Usability				
1. The program is easy to learn.				
2. The program is easy to use.				
3. The program is easy to adapt or change (as the need may arise).				
4. The program can be used for purposes beyond those for which it was created.				
5. The program is easy to explore using trial and error methods.				
6. The program responds at a reasonable speed.				
Content and structure				
7. The instructions on the computer screen are easy to read.				
8. The information on the screen is well structured.				

Statements	***strongly agree***	***agree***	***disagree***	***strongly disagree***
9. The instructions in the program are clear.				
10. The colour scheme used on the interface is adequate.				
11. The font size used on the interface is appropriate.				
12. The animation used on the interface is adequate.				
13. The graphics used on the interface are adequate.				
Terminology and system information				
14. The words on the screen are easy to understand.				
15. The feedback provided is adequate.				
16. The words introduced are at the appropriate level for the pupil.				
Navigation				
17. The program provides sufficient information such as table of content and instructions.				
18. The program provides facilities to help you assess the structure of the program.				
19. It is difficult to find your way around the program.				

Statements	***strongly agree***	***agree***	***disagree***	***strongly disagree***
20. It is difficult to return to a page viewed previously.				
21. You feel lost, when using the program				
Attention and motivation				
22. The program would motivate the pupil.				
23. The program is effective at maintaining the attention of the pupil.				
General				
24. The program would help children with ASD learn to read				
25. The program is effective and useable.				

Thank you for completing this questionnaire.

Appendix F

Human Computer Interaction (HCI) computer program attitude questionnaire

Name of program being evaluated:

The purpose of this exercise is to evaluate the educational computer program (named above). Please tick one response for each statement.

Statements	***strongly agree***	***agree***	***disagree***	***strongly disagree***	***Answer unknown***
System functionality /usability					
1. The program is easy to learn (learn to use).					
2. The program is easy to use.					
3. The program is easy to adapt/change (as the need may be).					
4. The program can be used for purposes beyond those for which it was created (extension in the program functions; additional utility).					
5. The program is easy to explore using trial and error method.					
6. The program responds at a reasonable speed.					
7. The feedback provided is adequate.					
The interface / information					
8. The instructions on the computer interface/screen are easy to read.					
9. The information on the screen is well structured.					
10. The instructions in the program/ interface are clear.					
11. The colour scheme used on the interface is adequate.					

Statements *(The interface/ information continued)*	***strongly agree***	***agree***	***disagree***	***strongly disagree***	***Answer unknown***
12. The font size used on the interface is appropriate.					
13. The animation used on the interface is adequate.					
14. The graphics/ images used on the interface are adequate.					
Terminology / grammar and system information					
15. The words on the computer screen are easy to understand.					
16. The words introduced are at the appropriate level for the pupil.					
Navigation					
17. The program provides sufficient information, such as table of contents and instructions.					
18. The program provides facilities to help you assess the structure of the program.					
19. It is difficult to find your way around the program.					
20. It is difficult to return to a page viewed previously.					
21. You feel lost when using the program					
Attention and motivation					
22. The program can motivate a child using it					

Statements *(Attention and motivation continued)*	***strongly agree***	***agree***	***disagree***	***strongly disagree***	***Answer unknown***
23. The program will be effective at sustaining / maintaining the child's using the program attention.					
Suitability for developing reading skills					
24. The program would help children with autism learn to read.					
Overall reaction to the program					
25. The program is appropriate and useable.					

Thank you for completing this questionnaire.

Appendix G

Simple Interrater Reliability Agreement using Two Coders – Marian Tuedor (student) and Jackie Meredith (consultant) October 2008

STUDY:
Design = 10 children (5 in each condition), 3 coding sequences across 2 packages = 60 possible coding events. 3 children in ASD population completed 1 package only, making 51 coding events overall.

RELIABILITY:
ASD children: 21 coding events, 20% coded – 4 cases.
TD children: 30 coding events, 4 comparative cases coded.

Child	Status	Package	Type of coding	Reliability
NKEM	TD	Sentence Master	1 – Visual Looking(duration)	99%
SHARON	TD	Speaking for Myself	2 – Touching (momentary)	81%
SHREY	TD	Sentence Master	2 – Touching (momentary)	92%
EHEN	TD	Speaking for Myself	3 – Stress/Boredom (duration)	100%
TOM	Autistic	Speaking for Myself	1 - Visual Looking (duration)	96%
JAMES	Autistic	Sentence Master	1 - Visual Looking (duration)	95%
ALEX	Autistic	Speaking for Myself	2 – Touching (momentary)	89%
STEPHEN	Autistic	Sentence Master	3 – Stress/Boredom (duration)	94%

Average Reliability across 8 cases = 93%

Appendix H

Middlesex University

Educational Computer Programs Design Standard (ECPDS) for Literacy Software Intended Children with Autistic Spectrum Disorder (ASD).

This document attempts to tackle the lack of standards to facilitate the design of educational computer programs to reinforce learning to read. The set of guidelines proposed was designed to serve as a "made to measure" guide for designer of educational computer programs for children with Autistic Spectrum Disorder (ASD). There are a total of <u>67 guidelines</u>.

General Information Summary

Detailed below is the introduction to the guidelines as well as 5 design standards for facilitating the design of appropriate computer programs for children with ASD. The areas addressed include:

- The Autistic Spectrum Disorder (ASD) learning style
- Reading for ASD
- Pedagogy for ASD
- Information processing memory and ASD
- Usability, adaptive and adaptive technology and assistive technology usability

Applying the guidelines

As ASD is a spectrum, the computer program should be designed to suit individual user requirements. Teachers and parents facilitating the use of the computer software need to be able to adapt the software to meet these requirements.

The reviewers have to use their discretion in employing this questionnaire, as it is a tool that should be used in conjunction with the reviewer's understanding of the subjects; as they know, the child and this questionnaire only serve as a guide and not an absolute for each user.

ECPDS Standard 1- Learning style and theories for children with ASD

Summary
This section of the guidelines discusses how to apply the learning style (ALS) to educational computer program design. The computer program should cater for the learning style of the child (for example, if the user is a visual learner, the use of symbols or photographs may support learning).

Refer to the additional information section of this document for more details on ALS.

Guidelines	**Comments and examples**
1. *Minimise content* Minimise the content of the interface.	The child with ASD may focus on small details; therefore, the content of the interface needs to be minimised. *Example*: One text and an image for each word taught.
2. *Bit site learning* Tasks should be small and introduced gradually.	The complexity of the program should increase at a minimal pace. *Example*: Restrict the content of each screen to one word and one image (as above) and increase to two or more only after five or more lesson.
3. *New topics* Identify teachable tasks and introduce them slowly.	Children with ASD have difficulty with new task or changes. E*xample:* New words should be introduced with either word or image animated into the screen followed by the sound.
4. *Restricted focus attendance* Emphasise the key task.	The child with ASD may focus on small details; therefore the content of the interface needs to be emphasised. *Example* Make the text bright and colourful and the image should be large.

Guidelines	**Comments and examples**
5. Reinforcement and motivation techniques Include techniques that will motivate the user.	Timely motivational prompts (audio or visual) to help to alleviate some of these problems. Example: The sound of audio prompting response or reward system (which could be an animated object, accompanied with audio of 'very good' or 'well done').
6. Attention Include tools such as animation and bright colours.	Animation may promote attention at an appropriate level for the user can help with attention problems. *Example:* An animation of an object; for, instance a fish swimming across the screen (note: there should be a repertoire of objects to select from as children with ASD have different likes and dislikes)
7. Adults' moderation of learning Design the program to be set-up and moderated by the teacher or parents and guardians of the child.	Many children with ASD and SLD need one to one support; therefore an adult should moderate the use of the program well.
8. Repetition In order to support the ASD learning style, there should be ample repetition.	As children with ASD and SLD have problems with imagination and attention, the repetition of each task is needed. *Example:* To teach the word 'bus', the lesson needs to be repeated a fair number of times (note that the levels of repetition should be adapted to suit individual children (see the section on profile and adaptable features))

Guidelines	**Comments and examples**
9. Cueing techniques: Cueing techniques should be provided to help to encourage the child to predict the word learnt.	This can be in the form of suggestions using images, or audio. *Example:* For each use of the word ‘bus’, the sound of a bus in motion can be produced by the computer.
10. The use of Audio or Sound Incorporating various sounds into the software.	Incorporating sound into the software for children with ASD will be stimulating and create auditory awareness as well as building listening skills. *Example* The sound of a motor cycle i.e. ‘vroom……vroom’.
11. Visual display and images Employ visual display, such as photographs, cartoons or drawings.	These tools are of immense benefit to children with ASD as they are typically visual learners. *Example:* Cartoons or photographs of the children favourite toys, places objects can be used (see adaptable features below)
12. Visual clues In the design, providing visual clues and instructions.	This is to remedy imagination difficulties in the child. *Example:* For the child to select or click an object, a bright image of a hand or an arrow pointing to object that needs to be clicked.

Guidelines	Comments and examples
13. Visual instruction Design the program with a visual instruction.	This is to remedy learning difficulties and memory problems. *Example:* Every instruction or task spoken must be accompanied by text, an image, sign language, symbol (separated or in combination; see profile and adaptable features below).
14. Optional Cursor The program should be designed to provide an alternate cursor.	Some children with ASD may respond better to a cursor which is a familiar object but various options should be provided (see profile and adaptable features below). *Example:* A cursor of a cartoon character that the child likes could be designed to point to the task; for instance, to select a particular word, a cartoon character could point at the word.
15. Structure in the interface Design the program to be structured and consistent.	Each page on the interface should have the same structure and there should be only slight changes; which in this case should be the word taught and contents associated with the word being taught.
16. Balance Design the program to balance the strengths (for example visual learning) and weaknesses (auditory learning) of both parts.	Uneven patterns of strengths and weaknesses should be balanced (as stated above).

Communication and ASD

Summary
Communication is vital to the success of the child's learning endeavour, so a varied array of communication tools and assistive technology should be supported by the program (more on communication is described in design standard 5; assistive technology, guidelines number 57-65).

Guidelines	Comments and examples
17. Design the program to provide varied tools to support communication especially in non-verbal children (see glossary below).	As communication is vital to the success of the child' learning endeavour, an appropriate level of communication should be provided. *Example:* A combination of symbols, text, signing of the word (by video-recordings or drawing) as well as photographs can be provide for all words taught.

Design Standard 2- Reading and for ASD

Summary
This design standard focuses on the best approach for teaching new words to children with ASD using computer software.

The reading approach to teaching new words is based on the whole language approach and the learning style of ASD. Other reading approaches can be introduced later on a trial basis (and removed if found to be unfavourable to the user; see adaptive features; guidelines number 51-56) when the child has achieved a level of competence in reading.

This part has to be done in conjunction with the national curriculum (this research suggests that a delay may be necessary in the introduction of phonic awareness in order to accommodate the ASD learning style).

Whole Language Approach

Guidelines	Comments and examples
18. One word at a time should be taught.	
19. The text of the word taught should be animated on the screen.	This is to catch the child's attention and bright colour is recommended. *Example:* Animation of the word, image or symbol on the screen.

Guidelines	Comments and examples
20. The word should be repeated several times in order to support memory problems in the child (this should be adaptable; see adaptable features, guidelines number 51-56).	*Example:* (as in number 8)
21. An image and symbol of the word taught should be animated on the screen alongside or shortly after the word.	(as in number 19)
22. A voice should say the word being taught. This voice ideally can be input into the program by an adult with whom the child is familiar.	A child with ASD will respond to a similar voice. *Example:* The teacher could replace the voices on the computer with hers/his (see profile and adaptable features below).
23. Simple fun and games (should be incorporated into the program so that learning to read is made interesting for the user).	Incorporating play, fun and games will promote the interest and sustain the attention of the user.
24. All of the tools employed should be consistent throughout the design.	*Example:* (as in number 15)

ECPDS Standard 3- Pedagogical recommendations

Summary
This section of the standard provides an overview of the mainstream pedagogical approach to ASD. More research on the benefits and limitations of the approaches may be needed see literature in the public domain (the National Autistic Society is the recommended place to start; listed in the reference section below)

Apply the desired pedagogical approach, taking into consideration the aim of the approach (see the glossary below for more details).

Guidelines	Summary of the aims of approach
A. *Applied Behaviour Analysis (ABA):*	The aims of the ABA programme are : ○ To create the prerequisite for children to learn naturally. ○ To maintain and use the skills learnt. ○ To create a very structured environment that will optimize learning. ○ To use computers to support learning.
B. Structure Positive Empathy and Low arousal (SPELL) .	The aims of the SPELL programme are : ○ Structure: The environment and structure should be predictable and promote independence and reduce anxiety. ○ Positive (approach and expectations): encouragement and skills acquisition. ○ Empathy: the understanding of autism and an attempt to see the world through their eyes. ○ Low arousal: The environment should reduce arousal. ○ Links: links with other professionals involved with the child and their parents or guardians.

Guidelines	Comments and examples
C. The High Scope approach	The aims of the high scope programme are to promote: ○ The principles of independence. ○ Active learning and collaboration ○ Respect for individuals. ○ The process whereby the child acquires reading behaviour. The child should be an active participant in learning and supported by computer-assisted Instructions.
D. The Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) programme	The aims of the TEACCH programme are: ○ The improved adaptation (of strategies to suit the child with ASD). ○ Parent collaboration ○ Individual based assessment structured teaching. ○ Skills enhancement. ○ Cognition and behaviour therapy. ○ Generalised training (having the whole understanding of the child).
E. Other programmes Other programmes employed in the pedagogical approach include : Daily life therapy, the integrations approach and the interactive approach.	

ECPDS Standard 4- Information Processing and memory

Summary
These guidelines provide instructions for dealing with information processing and memory problems in ASD children.

Guidelines	Comments and examples
25. Design the program in a way that the program will requires little prior knowledge to use.	The computer program should help to alleviate memory problems in the ASD user rather than compound them. *Example:* Bright colours and animation of the words being taught or images will be a good practice
26. Design the program with a familiar model (symbols, photo of objects or concepts) that the child can understand.	Using familiar images and icons will promote generalisations and inferential skills (as above). *Example:* A cartoon character or photography of favourite toy or place could be added into the program (profile and adaptable features below)
27. Design the program using images and icons with which a child with ASD will be familiar	This is to aid the child's memory and to avoid confusing the child. *Example:* The icon can be an image that the child likes or recognises.
28. Reduce the amount of information that the child has to remember.	Promoting memorising skills in the child and avoiding overloading the child with information or tasks. *Example:* (as above number 1)
29. Design the program with visual elements alongside audio ones.	*Example:* (see number 32)
30. In the design, identify and minimise the causes of distraction	This is to remedy the problem of attention (distractibility). *Example:* Animation and bright colour should be used.
31. The design of the program should integrate the new items taught into pre-existing items that are already known	Promoting generalisations and memory problems in ASD. *Example:* One word should be taught and then the number gradually increased.
32. Design the program to minimise negative behaviour that may arise due to over-stimulus or the excessive complexity of the program.	This may lead to confusion or frustration by employing the ASD learning style (see ECPDS 1 above). *Example:* One word, an image and then audio of the word taught

ECPDS Standard 5- Usability, Adaptable and Adaptive, Assistive Technology

Summary
This section of the design standard makes recommendations for designers in the area of usability, adaptable features and assistive technology.

Usability
The recommend guidelines below are aimed at directing the design of usable and efficient software for children with ASD.

Guidelines	Comments and examples
33. *Platform or operating system* Design the program supported operating systems in used.	The commonly used operating systems in schools in the United Kingdom are Windows and Apple.
34. *Visibility of system status* Design the program to keep the child informed about what is going on, through appropriate feedback within a reasonable time.	When the program is loading there should an image and text (which should be always visible) telling the child what is happening. *Example:* A symbol, text and signing of wait could be used.
35. *User control and freedom* Design the program to provide an emergency exit for the user to leave an unwanted state without having to go through an extended dialogue.	*Example:* A door image, symbol or sign language can be used as an error message as well as exit message.
36. *Flexibility and efficiency of use* Design the program to provide the flexibility for the program to be customised to suit individual children.	(see profile and adaptable features section below)
37. *Aesthetic and minimal design* Design the program to be aesthetic.	(see number 1)
38. *Recognition, diagnosis and recovery from error* Design the program to explain errors in a clear, precise way that is understood by the child, when the program malfunctions.	

Guidelines	Comments and examples
39. *Accuracy demands* Design the program to provide flexibility for inaccurate or random clicking by the child.	As the children are ASD children, so the system should be able to accommodate random clicking without crashing.
40. *Correct and accurate feedback* Design the program to give feedback if the response given by the child is accurate or delayed.	
41. *The response time* Design the program to minimise or increase the response time at the correct level for the child.	
42. *System status* Ensure that the visual status is well defined and visual.	This can be hidden from the child to avoid distracting him/her.
43. *Labelled icon* All icons to be labelled with text beneath the image.	This is to enable the child to recognise either the icon or the text beneath it.
44. *Pointing devise* Enable multiple clicks in the design.	The child may delay his/her response or may click multiple times so the system should be designed to accommodate this.
45. *Alert messages* Alert messages should be designed with audio as well as visual representation.	This is to draw the attention of the child or teacher to the alert message.
46. *Simple alert message* Make the messages short and simple	

Profile based

Summary

The ASD learning style has to be employed (on an individual basis) in order to fully support the child's learning. It is highly recommended that the program is designed to include the child's profile/ preferences which should be incorporated into the computer program. This can be designed to appear automatically at the beginning of the session; it should be defined (or set) as the child's preferences.

Guidelines	Comments and examples
47. Design the program to include various font sizes and colours in the user profile	
48. Design the program so that the child's preferred images and photographs can be added.	Details particular to the child's needs and preferences should be added to the profile
49. Design the program to include the desired volume level of the child to be added as a default setting in the child's profile	
50. Design the program to include the applicable communication tools and option in the child's profile	For example a child with ASD may use symbol in writing, reading or communication. If this is the case the profile should include the use of symbol along with text and/or audio.

Adaptable features

An appropriate program for children with ASD should be *flexibility and efficiency of use*. The program should be adaptable to suit individual children in the following areas.

Guidelines	Comments and examples
51. Sensory sensitivity Design the program to be adaptable to the sensory sensitivity of the child.	(as in the profile section above)
52. Animation and reward Design the animated objects and reward to be adaptable (increasing or deceasing to meet the child's needs).	(as in the profile section above)

Guidelines	Comments and examples
53. *Information* Design the on-screen information to be adaptable, so that the information could be increased or deceased.	(as in the profile section above)
54. *Prompt* Design the programs prompt to be adaptable so that information could be increased or deceased.	(as in the profile section above)
55. *Repetition* Design the levels of repetition in the program to be adaptable	Too much repetition can lead to frustration and negative behaviour in children with ASD. *Example:* Repetition should be regulated in the profile section above)
56. *Animation options* Design the program to display animation or static images	(as in the profile section above)

Assistive technology

Summary
Assistive technology provides children with ASD with the additional support they need to employ computer technology. The designer should ensure that the system does not disable or disrupt any assistive technology additional devices the child may need to use the computer program.

Guidelines	Comments and examples
57. *Voice input* Design the program to support a voice input facility (so that the teacher or adult voice can say the word being taught).	A child with ASD may respond to a familiar voice. *Example:* Record the teacher's voice to replace the inbuilt one (see profile above)
58. *Visual sensitivity* Design the program to provide an option for additional assistive technology tools to support visual sensitivity in the child.	The use of a colour overlay or recommendation for the user of the computer program to purchase a tinted screen to be placed over their computer either as an add-on or built-in. *Example:* A tinted overlay can be placed over the screen
59. *Assistive input devices* Design the program to support assistive input devices	*Examples:* Exemplars of input devices are switches, lager keyboards, joysticks, twiddlers, touch screen, etc.

Guidelines	Comments and examples
60. *Assistive output devices* Design the program to support assistive output devices	*Examples:* Exemplars of output devices are screen readers and screen enlargement
61. *Communication tools* Design the program to support a wide range of communication tools.	*Example:* (see number 59 and 60)
62. *Clicking interval options* Design the program to customise the clicking (amount of clicking) and clicking interval.	*Example:* (see profile section above)
63. *Avoid disruptions* Ensure that the design of additional assistive technology does not disrupt other features of the program.	
64. *Keyboard or multiple input devise* Design the keyboard to be used in place of the mouse for navigation (if necessary)	This will provide the child with an alternate input tool. *Example:* Touch screen, the system should support other assistive technology input devices (see numbers 59 and 60)
65. *Video recording* Video recording of sign language should be included for every demand, task or content taught.	*Example:* Addition of drawings or recordings of a person signing what is taught or the task requested will be good practice.

Additional guidelines

Documentation

Guidelines	Comments and examples
66. *Documentation (the teachers and parents/guardians' user manual)* The program should include an easy to read user manual for the teachers or parents/guardians.	The system like other application should include a user manual.
67. *Documentation (children manual)* The program should provide hard copy of all the content taught.	The content should be printable copy and should be included. This will provide additional tools for the child to employ in learning to write. *For example* Text, symbols, signing and PECS.[1]

COMPUTING JARGON

Some computer software categories are:

Computer Aided (or Computer Assisted) Instruction (CAI)
An acronym for Computer Aided (or Computer Assisted) Instruction, CAI, are educational programs that are designed to serve as teaching tools (Microsoft, 1999). CAI is usually used in tutorials, drills and question-and-answer sessions which are designed to test the user's comprehension. CAI systems are often used for presenting materials and for allowing the child to pace their speed whilst learning. CAI is also known as CAL, computer aided teaching or computer assisted teaching (CAT).

Computer Based Learning and Computer Aided (or computer assisted) Learning (CBL) and (CAL)
This is an acronym for computer based learning. It is commonly used with reference to CAI which focuses primarily on education or computer based training (CBT). An acronym for computer aided (or computer assisted) learning. A general definition of CAL is that it is a method for presenting educational material to a learner by means of computer programs which also gives the opportunity for individual interaction.

Multimedia programs

Multimedia is a computer-based method of presenting information by using more than one medium of communication, such as graphics, sound and emphasising interactivity. Multimedia may enable a user to have access to information; hypermedia enables the user to interact with the system.

Hypermedia program

The way in which a multimedia system enables you to interact with particular programs is made possible by the use of hypertext. Hypertext is a body of text where some or all of the information is linked, so that, when a user clicks on a word, you can obtain more about the word or be transported to another section of the document that contains related information. Hypermedia programs employ multimedia resources (graphics, video, animation and sound) in the production of an interactive technology.

[1] Picture Exchange Communication System (PECS) is employed as a picture-based communication tool for children with ASD.

PEDAGOGY APPROACH FOR AUTISTIC SPECTRUM DISORDER (ASD)

Detailed below are some of the teaching methods and strategies employed in special needs schools in the UK.

Structure Positive Empathy and Low arousal (SPELL)

SPELL is an acronym for Structure Positive Empathy and Low arousal. The Spell training aims at identifying the underlying issues of the disability and providing a means of communication for these children (National Autistic Society (c), 2006).

SPELL is the framework basis of staff training provided by National Autistic Society schools. This framework provides the ethical basis for the intervention they provide. Training is geared towards providing an understanding of, and a response to, the needs of adults and children with ASD.

This framework identifies the uniqueness of each person with autism and aims to develop strategies that are individualistic yet share a common identity, by interlinking any common issues that are peculiar to children with autism. This helps to promote personal development by working to reduce the difficulties associated with autism but also to build on the strengths of each individual with this condition (ibid).

The aim of the Spell framework is to sustain the following:

- Structure: The environment and structure should be predictable and promote independence and reduce anxiety.
- Positive (approach and expectations): encouragement and skills acquired.
- Empathy: understanding of autism and an attempt to see the world through their eyes.
- Low arousal: The environment should reduce arousal.
- Links: links with other professionals involved with the adult or child and their parents/guardians.

This method has been proven to be effective in many ASD schools in educating children with autism.

Applied Behaviour Analysis (ABA)

Applied behaviour analysis (ABA) dates back to Skinner and the animal experiments which showed that food rewards (immediate target for specific behaviour) can lead to behavioural change (Saffran, 1998).

The basic ideology behind this method of teaching is that children with autism often learn very little from the environment but they are capable of learning in a very structured environment. This programme, therefore, emphasises the importance of having a structured environment in order to promote learning in children with autism. This ideology assumes that, since the excesses and difficulties of autism result in learning blockages, intensive and structured teaching would help autistic children to overcome their problems (ibid).

The ABA programme emphasises the importance of having a structured environment after a certain age in order to promote learning (learning to read, writing, mathematics and other subjects). The ABA approach employs methods which help to maintain the skills learnt, to ensure that the learnt skills are applied and not forgotten and to promote learning. A commonly used sector of the ABA programme is the Lovaas method, also known as the UCLA (University of California Los Angeles) programme. The Lovaas method is a home-based intervention model for early intervention, involving 40 hours a week of intensive therapy (National Autistic Society (b), 2005).
The aims of ABA are:

- To create the prerequisite for children to learn naturally.
- To maintain and use the skills learnt.
- To create a very structured environment that would optimize learning.
- To use computers to support learning.

Most of the above listed aims have made this method popular amongst the parents of children with autism.

The High Scope approach

The High Scope approach is a way of working with young children that is derived from Piaget's theory of child development and is based on the idea that children learn best from activities which they plan and carry out themselves. The High Scope approach promotes the principles of 'independence, active learning, collaboration and respect for individuals', whereby the child acquires the reading behaviour as well as being an active participant in their learning, supported by computer-assisted instructions (High Scope Educational Research Foundation, 2008).

Amongst the many benefits of using the High Scope approach is the fact that it develops the ability of self-expression in children so that they can speak, write or show, through pictures or movements, their experiences to others.
The problem is that children with autism may lack the ability and skills for self-expression, as advocated by this approach. This teaching approach is not as commonly used as TEACCH and SPELL in specialist schools for autistic children.

Teacch

The Teacch programme started in 1966 at the University of North Carolina in the USA. It began as a child research project to provide services for children with autism and their families. The Teacch programme is intended to equip children with autism and their families with the help and skills they need in order to function effectively in their communities. This may be at home, at work or in education (National Autistic Society (a), 2008).
Some of the benefits of utilising the Teacch approach include:

- Improved adaptation (of strategies to suit the child with ASD).
- Parent collaboration
- Individual based assessment
- Structured teaching
- Skills enhancement
- Cognition and behaviour therapy
- Generalised training (having the whole understanding of the child)

Other pedagogical practices not discussed but employed in teaching and invention for children with ASD include; the daily life therapy (a programme which originated in Japan. The teaching approach is based on Japanese culture aimed at integrating children with ASD with typically developing children; Quill 1989), integrations approach (where children with ASD were taught together with typically developing children) and the interactive approach (a relationship based approach), as detailed by Jordan and Jones (2000).

COMMUNICATION METHODS AND TOOLS FOR ASD CHILDREN

Use of Objects

Concrete objects are sometimes employed as the initial communication tool for children with ASD. Peeters (2001) noted the importance of adapting teaching to accommodate the brain functioning of people with autism. Peeters (ibid) stressed that an object may have particular meanings for many children with autism who struggle to understand the world which they may find confusing.

Picture Exchange Communication System (PECS)

Picture Exchange Communication System (PECS) or the uses of Visual Interaction Augmentation (VIA) are strategies whereby a picture of a desired object is exchanged for the object itself. This are ways of supporting preverbal communication in children with ASD by using visual icons to augment the receptive and expressive meaning of spoken words, where speech is present, or as an alternative means of communication, where speech is absent.

Symbols

Symbols are line drawings accompanied by words. Some people with autism may prefer written words to spoken ones (hyperlexia). It is good practice to accompany visual aids with spoken words. Also, it is important for understanding to be present in the person with autism before this method is introduced.

The benefits of applying symbols in software development are:

- The use of symbols may enhance spoken words in visual learners.
- The use of symbols may promote learning in children with ASD.
- The use of symbols may promote understanding in children with ASD.
- The use of symbols may facilitate communication in children with ASD.
-The use of symbols may be more appropriate than photographs for some children with ASD since they tend to perceive details more than the whole.

Sign Language

Sign language for the deaf is widely employed by children with ASD. Signalong is a means of communication designed especially for people with learning disabilities. It is based on British Sign Language (BSL). Nearly all the signs are unaltered and the most iconic signs are selected where a choice exists. There are a few signs which have been adapted for ease of use and some signs have been invented where no appropriate BSL signs could be found or where ambiguity has arisen.

Electron communication aid and Augmentative Communication

Electron communication aids can be used to support children with communication difficulties, using symbols, pictures, and sound (real and synthetic). This can be added to the images on a computer program in order to promote continuity in the learning and communications tools (such as augmentative communication aid; b for example the Dynavox[2]) employed in the child's education (see design standard 5; for adaptive and adaptive tools).

[2] The Dynavox is a communication device for children who need assistive technology to speak. The child types the word or selects the symbol of the word they want to say and the device vocalises it for them.

Communication is vital to the success of the ASD children as a learning and communication tool. Detailed below are common communication tools along with their benefits and limitations:

Communication mediums	Strengths and weaknesses
Object	Restrictive
PECS	Less restrictive
Symbols	Less restrictive
Sign Language	More flexible
Augmentative Communication	More flexible

References

Alliance for Technology Access (2000). Computer and Web Resources for People with Disabilities: A Guide to Exploring Today's Assistive Technology. (3rd ed). Hunter House.

Frith, U. (1989). Autism Explaining the Enigma. Oxford, Basil Blackwell.

High / Scope Educational Research Foundation (2008). Curriculum, High / Scope Educational Research Foundation. [Online].Available from https://secure.highscope.org/Content.asp?ContentId=1 [Accessed March 26th 2009].

National Autistic Society (2008a). Computer Application for People with Autism. [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d108&a=3276 [Accessed 13th January 2009].

National Autistic Society (2008b). What is Lovaas Method? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=297&a=3345 [Accessed 11th January 2009].

National Autistic Society (2008c). What is the SPELL Framework? [Online] Available from http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=297&a=3362 [Accessed 11th January 2009].

Nielsen and Molich (1990). How to Conduct a Heuristic Evaluation. [Online] Available from http://www.useit.com/papers/heuristic/heuristic_evaluation.html [Accessed 11th January 2009].

Nielsen, J. and Mack, R.L. (1994). Usability Inspection Methods. New York, John Wiley & Sons.

Parents let's Unite for Kids (PLUK), (1998). Family Guide to Assistive Technology. [Online] .Available from http://www.pluk.org/AT1.html. [Accessed 26th June 2009].

Peeters, T. (2001). The Language of Objects. Helping Children with Autism to Learn. In S. Powell (ed.). London, David Fulton publishers.

Saffran, R. (1998). Curriculum Outline for Behavioural Intervention Program for a Young Child.

Wing. L, Ed. (1996). The Autistic Spectrum. London, Constable Press.

Appendix I

Middlesex University

Interview Schedule Human Computer Interaction (HCI) professional

The purpose of this interview is to obtain your views regarding the educational computer programs ('Speaking for Myself' / 'Sentence Master')

Name of computer program evaluated:

1. What will you consider to be the positive/ good aspects of the computer program of ….. (identify the program?

2. What are the problems you encountered whilst using the computer program; this can include usability or any other problems?

3. Are the features such as sounds, navigation tools, structure and layout of the program adequate/ good and do you consider them to be appropriate?

4. Are the functionalities (such as menus and toolbars) provided by the program adequate/ good do you consider it to be appropriate?

5. In what way do you think computer program can be improved; in aspects such as design and usability aspects?

6. Please comment on the following aspects of the computer program:

Structure and layout ---

Graphics/ images---

Audio/speech used ---

Reward /animation---

Video (if applicable) --------------------------------------

8. Discuss the attitude questionnaire (individually and, comparing scores/ selection ticked) go through the questions with interview

Noting responds and discussing:

- Each question
- Discrepancies and oddities (noted in the score)
- Comparing chooses in selected options

7. Do you have any other comments or recommendations?

Informal/additional questions can be added at this point:

Question:

Response:

Appendix J

Middlesex
University

Interview Schedule

The purpose of this interview is to obtain the views of the ***teaching staff*** *of pupils with ASD on the use of educational computer programs to teach reading in the classroom and to solicit their views on the pupils' interaction with the computer programs, 'Speaking for Myself' and 'Sentence Master'.*

Name of program being evaluated:

Venue of Interview:

Date of interview:

Interviewee ID:

Time of interview:

General questions on the use of educational computer programs

1. Are educational computer programs used in your classroom to teach reading?

   If the response is "no", inquire why that is the case? (Then go to question 6)

2. *(If the response is "yes", complete question 2-5)* What type of educational program do you use?

- ☐ Multimedia program (text, graphic, photograph, animation, sound)
- ☐ Non-Multimedia program
- ☐ Other (specify)…………………………………………

3. What aspect of reading does the program teach (for example, does it teach phonological awareness, vocabulary acquisition, etc)?

4. What do you consider to be the benefits of using computer technology in the classroom?

5. Could educational computer programs be used as re-enforcement to teaching reading in the classroom?

Intervention A: 'Speaking for Myself'

6. What do you regard as the key function/s of the program 'Speaking for Myself'

   ………………………..……………………………………….?

   Developing non-verbal communication ☐

   Developing phonological awareness ☐

   Vocabulary acquisition ☐

   Other ☐

   Please specify……………………………..

7. What would you consider to be the average time span for which the program will hold the attention of a pupil?

0-20 sec	20-50 sec	1-5 minutes	5-10 minutes	more

8. Is the score you have given for the above question adequate or does this aspect of the program need improvement?

9. What would you consider to be the benefits of the program?

10. What are the limitations of this program?

11. How do you think the pupils respond to the program?
12. What are the main problems the participants encountered whilst using this program?

13. How effective is the program in maintaining the attention of the pupils?

14. How effective is the program in keeping the pupils motivated?

15. How well do you think the program impacted on the overall reading skills of the pupils?

16. What other skills does using this program promote in the pupils?

17. *Areas to be addressed/ recommendation*

18. Do you have any other comments or recommendations on how the program 'Speaking for Myself' could be improved to accommodate the needs of pupils with ASD?

Intervention B: Sentence master

19. What do you regard as the key function/s of the program 'Sentence Master'

    ……………………..……………………………………..?

- Developing non-verbal communication ☐
- Developing phonological awareness ☐
- Vocabulary acquisition ☐
- Other ☐
- Please specify……………………………..

20. What would you consider to be the average time span for which the program will hold the attention of a pupil?

0-20 sec	20-50 sec	1-5 minutes	5-10 minutes	more

21. Is the score you have given for the above question adequate or does this aspect of the program need improvement?

22. What would you consider to be the benefits of the program?

23. What are the limitations of this program?

24. What are the main problems the participants encountered whilst using the program?

25. How do you think the pupils responded to the program?

26. How effective is the program in maintaining the attention of the pupils?

27. How effective is the program in keeping the pupils motivated?

28. How well do you think the program impacted on the overall reading skills of the pupils?

29. What other skills does using this program promote in the pupils?

30. *Areas to be addressed/ recommendation*

31. Do you have any other comments or recommendations about how the program 'Sentence Master' could be improved to accommodate the needs of pupils with ASD?

Additional/Informal questions can be added at this point:

Question:

Response:

Appendix K

List of Computer Programs Employed in Implementing this Research

Name of the program	Manufacturer	Version/Edition	Function
1. Writing with Symbols 2000	Widgit software Ltd	2.615	Communication program for children with special needs
2. QSR N6 2002	QSR N6 software Ltd		Qualitative data analysis software
3. IIVHS player,	Panasonic	HS960 IIVHS	Use to play the video recording of the observation
4. 14-inch television	JVC		Use to show the video recording
5. Editing controller	ww-EC500E.	ww-EC500E.	Coding devise, Use to code the video recording
6. Final Cut Pro		version 4.5	Editing software
7. SPSS for Windows	SPSS	Version 14 &16	Quantitative analysis software

Appendix L

CHILD ___________________________________ ***SOFTWARE*** ___________________________________

1 - VISUAL ATTENTION *(CHILD <u>LOOKS</u> AT SCREEN WITH/WITHOUT TOUCHING) – duration event*

			LOOKS AT SCREEN	***COMMENTS***
	ONSET	***OFFSET***		
Total				

Duration of the session:………..

CHILD ___________________________________ ***SOFTWARE*** ___________________________________

2 - RESPONSIVENESS *(CHILD <u>TOUCHES</u> WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) momentary events*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
Total						

CHILD ___________________________________ ***SOFTWARE*** ___________________________________

3 – STRESS/BOREDOM INDEX *(CHILD DISPLAY ANY OF THE FOLLOWING BEHAVIOURS) – duration event*

EVENT ONSET	***EVENT OFFSET***	***FLAPPING HANDS/ COVERING EAR WITH HAND /OTHER REPETITIVE HAND MOVEMENT***	***CONTINUOUS VOCALISISNG***	***NEGATIVE AFFECT***

Appendix M

Glossary of terms /Acronym employed in the thesis

Glossary General

Acronym	Meaning
ASD	Autistic Spectrum Disorder
CAI	Computer Assisted Instruction / Computer Aided Instruction
CAL	Computer Assisted Learning / Computer Aided Learning
CBL	Computer Based Learning
CBT	Computer Based Training
DVD	Digital versatile Disc or Digital Video disc (DVD), used for video and data storage
ECDL	European Computer Driving Licence
ICT	Information Communication Technology
M	M represent mental level
MAKATON	Sign language for the deaf, widely used by people with ASD
MAC	Apple MAC Computer
PC	Personal Computer
PECS	Picture Exchange Communication System
IT	Information Technology
HCI	Human Computer Interaction
SPSS	Statistical Package for the Social Sciences
SLD	Severe Learning Disability
VIA	Visual Interaction Augmentation

Statistics Glossary

Acronym	Meaning
DF	Degree of freedom
NS	Non significant
P	Probability level
SD	Standard deviation
T	Statistical hypothesis test
V	Expresses the degree of freedom
Z	The normally distributed value

Glossary of Types / Pedagogical approach in Computer Programs

Acronym	Meaning
EG	Educational Games
PS	Problem solving
RP/ERP	Reading programs /Educational Reading Program
S	Simulation Software
TDP	Tutorial Drill and Practice

Glossary of Reading Methods

Reading methods	Overview
Traditional method/ Alphabetic method	The traditional method is the need to identify words before the meaning can be constructed; from the words. This method primarily uses flashcards as a medium to teach reading. This is done by a process commonly known as rote learning.
Phonetic method	Phonics is the relationship between the sounds and writing system of a language. It is a method of teaching reading by encouraging children to sound out letters and blend the sound together for example /m/ –/aa/ -/t/ pronunciation mat.
Alphabetic method	The alphabetic method is the method of teaching reading by decoding letter to sound, for example caa /aa /taah/ spells cat.

Glossary of Reading Processes

Reading processes	Overview
Content and syntax process	Content is concerned with the factors that influence the interpretation of meaning of words. Syntax is the aspect of grammar that is concerned with the way words are ordered.
Phonological process	The word phonological encompasses sounds in words and how it relates to reading. It refers to the function of the auditory system that identifies and processes sounds as well as sound patterns that are linguistically meaningful.

Reading processes	**Overview**
The Orthographic / whole language / language experience process	Orthographic refers to the spelling of words. This process is often called disparagingly. Decoding is the process of building up words from letters, hence disparaging decoding deals with the construction of words from individual letters.
Semantic and comprehension process	Semantics involves with the meaning of words. This process deals with the way word meaning (also known as Semantics) build up into sentence and its meaning.

Appendix N

School of Computing Science

Ethics Committee

Terms of Reference

The Ethics Committee will implement University Ethics committee policy and focus on issues that support sound arrangements within the School to promote and maintain high ethical standards by:

- Ensuring that suitable procedures are in place for approving both staff research proposals and all student projects;
- Liaising with the University Ethics Committee and relevant School committees on ethical issues;
- Liaising with relevant School Committees and Management to ensure that ethical issues form part of the curriculum on CS programmes;
- Ensuring that staff development activities in the School include workshops on ethical issues and the procedures for handling them.

Membership

A representative from each Academic Department
An external expert
Associate Dean of Research (and representing School Executive)
Manager of the Campus Research Office
Not more than three additional members of the School with relevant expertise and experience (these experts can at the same time be representatives of an academic group)
A representative of any other expertise deemed necessary may be invited for specific meetings.

Reports to:

School Board

Frequency of meetings

Three per year: September, January and June. Other meetings may be convened in exceptional circumstances. Committee work may be carried out via email communications as appropriate between the meeting dates.

Minutes and Agenda

Available from Chair, Secretary.

Appendix O

Appendices of Results

This section of the appendices illustrates the figures and tables illustrated in the thesis. The figures and tables are presented in chapters (from 5 to 7) and are listed in numerical order.

Chapter 5

Illustrated below are tables and figures depicted in chapter 5.

Visual Attention (Looking)

TABLE 5.2: LOOKING TIME FOR SOFTWARE FM (ASD)			TABLE 5.3: LOOKING TIME FOR SOFTWARE SM (ASD)		
Child	***Session duration***	***Results in seconds of looking duration***	***Child***	***Session duration***	***Results in seconds of looking duration***
ASD1	252	73	ASD1	252	204
ASD2	269	191	ASD2	275	176
ASD3	379	233	ASD3	0	0
ASD4	0	0	ASD4	323	218
ASD5	0	0	ASD5	357	85

ASD 4 and ASD5 were absent from session FM and child from the SM session

Interaction/ Responsiveness (motivation)

TABLE 5.6 :FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT IN SOFTWARE FM (ASD)					TABLE 5.7: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT IN SOFTWARE SM (ASD)				
Child	**Physical Prompt**	**Verbal Prompt**	**Computer Prompt**	**Spontaneous Touch**	**Child**	**Physical Prompt**	**Verbal Prompt**	**Computer Prompt**	**Spontaneous Touch**
ASD1	35	34	0	1	ASD1	100	84	0	0
ASD 2	86	77	51	34	ASD2	44	47	47	0
ASD 3	5	8	202	119	ASD3	-	-	-	-
ASD 4	-	-	-	-	ASD4	101	43	68	0
ASD 5	-	-	-	-	ASD5	47	29	0	0

Child 4 and 5 were absent from session FM and child from the SM session

TABLE 5.8: FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT IN SOFTWARE FM (TD)				
Child	***Physical Prompt***	***Verbal Prompt***	***Computer Prompt***	***Spontaneous Touch***
TD1	0	2	0	37
TD 2	0	2	0	26
TD3	0	3	0	55
TD4	0	2	0	58
TD5	0	3	0	26

TABLE 5.9:FREQUENCY OF TOUCH BEHAVIOUR FOLLOWING DIFFERENT TYPES OF PROMPT IN SOFTWARE SM (TD)				
Child	***Physical Prompt***	***Verbal Prompt***	***Computer Prompt***	***Spontaneous Touch***
TD1	0	5	20	0
TD2	0	0	8	0
TD3	0	0	39	0
TD4	0	1	34	0
TD5	1	7	4	1

Chapter 6

Illustrated below are tables and figures depicted in chapter 6.

TABLE 6.3: ATTITUDE OF TAS - USABILITY BASED QUESTIONS (FM)		
No	**Attitude questions on systems/programs**	**Attitude**
5	The program is easy to explore using trial and error methods.	3
6	The program responds at a reasonable speed.	3
19	19. It is difficult to find your way around the program.	3

TABLE 6.4: ATTITUDE OF HCS - USABILITY BASED QUESTIONS (FM)		
No	**Question**	**Attitude**
2	The program is easy to use	3
6	The program responds at a reasonable speed	4

TABLE 6.5: ATTITUDE OF TAs - USABILITY BASED QUESTIONS (SM)		
Question no	**Question**	**Grade of no & attitude**
5	The program is easy to explore using trial and error methods.	3
21	You feel lost, when using the program	3
25	The program is effective and useable	3

TABLE 6.6: ATTITUDE OF HCs - USABILITY BASED QUESTIONS (SM)		
Question no	**Question**	**Grade of attitude**
1	The program is easy to learn	3

TABLE 6.7: ATTITUDE OF TAS - STRUCTURE AND CONTENT OF THE PROGRAMS (FM)

No	Attitude questions on systems/programs	Attitude
7	The instructions on the computer screen are easy to read	3
8	The information on the screen is well structured.	3
9	The instructions in the program are clear	3
17	The program provides sufficient information, such as a table of contents and instructions	3

TABLE 6.8: ATTITUDE OF HCS - STRUCTURE AND CONTENT OF THE PROGRAMS (FM)

No	Question	Attitude
7	The instructions on the computer screen are easy to read.	2
9	The instructions in the program are clear.	2

TABLE 6.9: ATTITUDE OF TAS- STRUCTURE AND CONTENT OF THE PROGRAMS (SM)

Question no	Question	Grade of no & attitude
7	The instruction on the computer is easy to read	3
9	The instructions in the program are clear	3
18	The program provides facilities to help you assess the structure of the program.	3

TABLE 6.10: ATTITUDE OF HCS- STRUCTURE AND CONTENT OF THE PROGRAMS (SM)

Question no	Question	Grade of attitude
8	The instructions on the computer screen are easy to read	4
15	The words on the screen are easy to understand	4

TABLE 6.11: ATTITUDE OF TAS - LEARNING STYLE OF THE USERS (FM)

No	Question	Attitude
12	The animation used on the interface is adequate (for users with autism)	2
16	The words introduced are at the appropriate level for the pupil/user	3
22	The program would motivate the pupil/user	3

TABLE 6.12: ATTITUDE OF HCS - LEARNING STYLE OF THE USERS (FM)

No	Question	Attitude
12	The animation used on the interface is adequate (for a user with autism)	3
22	The program would motivate the pupil/user	3

TABLE 6.13: ATTITUDE OF TAS - LEARNING STYLE OF THE USERS (SM)			TABLE 6.14: ATTITUDE OF HCS - LEARNING STYLE OF THE USERS (SM)
Question no	**Question**	**Attitude**	No similar attitudes were recorded
12	The animation used on the interface is adequate	2	
22	The program would motivate the pupil / user	3	
16	The words introduced are at the appropriate level for the pupil.	3	

TABLE 6.15: ATTITUDE OF TAS – ENJOYMENT / GENERAL QUESTIONS (FM)			TABLE 6.16: ATTITUDE OF HCS – ENJOYMENT / GENERAL QUESTIONS (FM)
Question no	**Attitude questions on systems/programs**	**Attitude**	No similar attitudes were recorded.
4	The program can be used for purposes beyond those for which it was created.	3	

TABLE 6.17: ATTITUDE OF TAS – GENERAL / OTHER QUESTIONS (SM)			TABLE 6.18: ATTITUDE OF HC – GENERAL / OTHER QUESTIONS (SM)
Question no	**Attitude questions on systems/programs**	**Attitude**	No similar attitudes were recorded.
4	The program can be used for purposes beyond those for which it was created.	3	
24	The program would help children with ASD to learn to read.	3	

TABLE 6.19: DISAGREEMENT OVER THE TAS IN FM

No	Question	scores
15	The feedback provided is adequate.	2,3
20	It is difficult to return to a page viewed previously	3,2
21	You feel lost, when using the program	3,2
23	The program is effective at maintaining the attention of the pupil.	2,3
24	The program would help children with ASD learn to read	2,3

TABLE 6.20: DISAGREEMENT OVER THE HCS IN FM

No	Question	scores
1	The program is easy to learn	3,2
5	The program is easy to explore using trial and error methods.	4,2
9	The information on the screen is well structured.	3,1
12	The font size used on the interface is appropriate.	3,2
14	The graphics used on the interface is adequate (appropriate for children with autism).	4,2
17	The program provides sufficient information such as table of content and instructions.	3,2
20	It is difficult to return to a page viewed previously	4,1
21	You feel lost, when using the program	3,1

TABLE 6.21: DISAGREEMENT OF BOTH TAS SOFTWARE SM		
Question no	**Question**	**Grades of attitude**
6	The program responds at a reasonable speed.	2,3
8	The in formation on the screen is well structured.	2,3
12	The animation used on the interface is sufficient / adequate.	2,3
15	The feedback provided is sufficient/ adequate.	2,3
17	The program provides sufficient information such as table of content and instructions.	2,3
19	It is difficult to find your way around the program	3,2
20	It is difficult to return to the page viewed previously.	3,2

TABLE 6.22: DISAGREEMENT OF BOTH HCS SOFTWARE SM		
Question no	**Question**	**Grades of attitude**
21	You feel lost, when using the program	2,4

TABLE 6.23: DIFFERENT LEVELS OF AGREEMENT IN TAS ATTITUDES (FM)		
Question no	**Question**	**Attitude scores**
1	The program is easy to learn	4,3
2	The program is easy to use.	4,3
10	The colour scheme used on the interface is appropriate for a user with autism).	4,3
11	The font size used on the interface is appropriate for a user with autism	4,3
14/15	The words on the screen are easy to understand	4,3

TABLE 6.24: DIFFERENT LEVELS OF AGREEMENT IN HCS (FM)		
No	**Question**	**Attitude/ scores of**
14/15	The words on the screen are easy to understand	3,4

TABLE 6.25: DIFFERENT LEVELS OF AGREEMENT IN TAS ATTITUDES (SM)		
Question no	Question	Attitude scores
1	The program is easy to learn	4,3
2	The program is easy to use.	4,3
10	The colour scheme used on the interface is appropriate for a user with autism).	4,3
11/12	The font size used on the interface is appropriate for a user with autism	4,3
14	The words on the screen are easy to understand	4,3

TABLE 6.26: DIFFERENT LEVELS OF AGREEMENT IN HCS (SM)		
No	Question	Attitude/ scores of
11/12	The font size used on the interface is appropriate for a user with autism	4,3

Chapter 7

Illustrated below are tables and figures depicted in chapter 7.

TABLE 7.6: PROFICIENCY OF THE COMPUTER PROGRAM (TAS) SM	
Categories	Direct interpretation
Design	-Good layout and design
Interactivity	-Good use of interactivity
Repetition	-Good use of repetition
Other	-Eye-hand co-ordination

TABLE 7.7: PROFICIENCY OF THE COMPUTER PROGRAM (HCS) SM	
Categories	Direct interpretation
Design	-The interface is well designed
Usability issues	-Linear design -Navigation
Interactivity	-Focused -Interactive - It is visual and immediate -Give a sense of progress/achievement
Reward	-Good reward system
Repetition	-Can promote learning

TABLE 7.8:PROFICIENCY OF THE COMPUTER PROGRAM (TAS) FM	
Categories	**Direct interpretation**
Multimedia/varied device	-Varied communication mode/ medium
Assistive technology	-Sign language -Eye-hand co-ordination -Promotes mobility skills
Other issues	-Eye-hand co-ordination

TABLE 7.9: PROFICIENCY OF THE COMPUTER PROGRAM (HCS) FM	
Categories	**-Direct interpretation**
Interface	-Good visual finish -Good design
Assistive technology	-Use of makaton -Use of multimedia
Multimedia/varied devices	-Interactivity (pictures, sound ,video and flash cards)
Other	-Good use of multimedia technology

TABLE 7.10: RECOMMENDATIONS MADE (TAS)	
Categories	**Direct interpretation**
Interface	-Use a bright font colour -Indicate the start and end of the session
Effects	-More animation -Sound to get the attention of the children
Adaptability	-Make more child-specific/ adaptable
Content	-Find more interesting ways to teach words -Reduce number of words on screen
Other	-More fun features -choice of words needs to be familiar

TABLE 7.11: RECOMMENDATIONS MADE (HCS)	
Categories	**Direct interpretation**
Interface	- Design need polishing -More sophistication
Usability issues	-Better navigation needed
Interactivity	-More interactivity is needed
Reward	-May be better based on scores
Repetition	-Limited repetitions
Other	Assessment (testing the words taught)

TABLE 7.12: OMISSIONS FROM THE FM COMPUTER PROGRAM			**TABLE 7.13: OMISSIONS FROM THE SM COMPUTER PROGRAM**		
Categories	**Direct interpretation**	**Naturalistic generalisation**	**Categories**	**Direct interpretation**	**Naturalistic generalisation**
Reward	No reward	Learning style	Reward	Problems of reward (not immediate	Learning style
Attention	Problems of attention	Learning style	Assistive technology	Lack of suitable communication methods	Learning style
Interest	Problems of interest	Learning style	Attention	Problems of attention	
Motivation	Problems of motivation	Learning style	Motivation	Problems of motivation	Learning style
Boredom	Problems of boredom	Learning style	Boredom	Problems of boredom	Learning style
Navigation	Navigational problems/ response time	System design	Repetition	Problems of too much repetition	Learning style
			Navigation	Navigational problems/ response time	Learning style System design

TABLE 7.14 FINDINGS AND RECOMMENDATIONS FROM THE INTERVIEWS

Design consideration	Communication assistant	Autistic unit coordinator and ICT coordinator
Adaptability of the program	-Multimedia program that is adaptable; where you can add or remove graphics is preferred.	-Design a computer program that is adaptable; where you can add or remove graphics is preferred. -A program customised with the child's name (under preference where everything related to the child is recorded)
Program aesthetics and layout	Background colour of the interface Plain blue or green (red may be too aggressive)	Background colour of the interface Plain blue or green (red may be too aggressive) Font colour - Bright colours Font size -Made adaptable/customisable Font style -Made adaptable/customisable
Graphics usage	-A photo that could be drawn over is most appropriate. -A cartoon photo could be used for children who are more able and able to generalise/transfer knowledge.	-Different things work with different children. The photo/graphic (if it is utilised) has to be relevant to the child -A photo that could be drawn over is most appropriate -A cartoon photo could be used for children who are more able and able to generalise/transfer knowledge
Interactivity in the program	-A degree of animation/movement works with children with autism.	-Maximum levels of interactivity/feedback should be given (as this helps to motivate children with autism) -Busy programs have their place. A degree of animation/movement works with children with autism.

Appendix P

Sample of coded observation forms

CHILD: TD4 Typically Developing (TD) **SOFTWARE:** Sentence Master (SM)

2 - RESPONSIVENESS *(CHILD TOUCHES WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) – momentary event*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
0.10			***Y***	***Y***		
0.16			***Y***	***Y***		
0.24			***Y***	***Y***		
0.36			***Y***	***Y***		
0.46			***Y***	***Y***		
0.58			***Y***	***Y***		
1.07			***Y***	***Y***		
1.16			***Y***	***Y***		
1.25			***Y***	***Y***		
1.34			***Y***	***Y***		
1.42			***Y***	***Y***		
2.03			***Y***	***Y***		
2.08			***y***	***y***		

Coding screen 1 / 2…………….

CHILD: TD4 Typically Developing (TD) **SOFTWARE:** Sentence Master (SM)

2 - RESPONSIVENESS *(CHILD TOUCHES WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) – momentary event*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
2.13			***Y***	***Y***		
2.31			***Y***	***Y***		
2.37			***Y***	***Y***		
2.42			***Y***	***Y***		
2.55			***Y***	***Y***		
2.59			***Y***	***Y***		
3.04			***Y***	***Y***		
3.08			***Y***	***Y***		
3.30			***Y***	***Y***		
3.34			***Y***	***Y***		
3.37			***Y***	***Y***		
3.56			***Y***	***y***		

Coding screen 1 / 2…………….

CHILD: ASD4 Autistic Spectrum Disorder (ASD) **SOFTWARE:** Speaking for Myself (FM)

2 -RESPONSIVENESS *(CHILD TOUCHES WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) – momentary event*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
0.2			***Y***	***Y***		
0.7		***y***				
0.11	***y***					
0.13			***Y***	***Y***		
0.19, 0.21 ,0.24, 0.25, 0.26, 02.27			***Y***	***Y***		
0.29			***Y***	***Y***		
0.31			***Y***	***Y***		***Smile at teacher***
0.33,0.35, 0.37, 0.39, 0.40, 0.42, 0.43, 0.43, 0.45			***Y***	***Y***		
0.48, 0.49, 0.51, 0.52, 0.53, 0.54			***Y***	***Y***		
0.56			***Y***	***Y***		
1.01, 1.04, 1.06, 1.07, 1.09, 1.10, 1.11,			***Y***	***Y***		
1.13, 1.14, 1.15, 1.16, 1.17, 1.18, 1.19			***Y***	***Y***		

Coding screen 1 / 2…………….

CHILD: ASD4 Autistic Spectrum Disorder (ASD) **SOFTWARE:** Speaking for Myself (FM)

2 - RESPONSIVENESS *(CHILD TOUCHES WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) – momentary event*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
1.21, 1.23, 1.24, 1.26, 1.28, 1.29, 1.31, 1.34, 1.36			***y***	***y***		
1.39, 1.40, 1.42, 1.43, 1.45			***Y***	***Y***		***smiling***
1.47, 1.49, 1.50, 1.52, 1.53, 1.54, 1.55			***Y***	***Y***		
1.53, 1.54, 1.55,			***Y***	***y***		
1.57, 1.58,1.59			***Y***	***y***		
2.0, 2.03, 205, 2.06, 2.07, 2.08, 2.09			***Y***	***Y***		
2.11, 2.13, 2.14, 2.17, 2.18, 2.20			***Y***	***Y***		
2.21, 2.23, 2.25, 2.26, 2.27, 2.29, 2.30, 2.31			***Y***	***Y***		
2.32, 2.33, 2.34, 2.35, 2.36			***y***	***Y***		
2.41, 44,45,46,47,48,49			***Y***	***Y***		
2.51,55,57,59			***Y***	***Y***		***Smile at teacher***
3.0,01,03,04,05,06,07,09			***Y***	***y***		

Coding screen 1 / 2…………….

CHILD: ASD4 Autistic Spectrum Disorder (ASD) **SOFTWARE:** Speaking for Myself (FM)

2 - RESPONSIVENESS *(CHILD TOUCHES WITH/WITHOUT LOOKING THE SCREEN AS RESPONSE TO PROMPTS) – momentary event*

ONSET	***PHYSICAL PROMPT***	***VERBAL PROMPT***	***COMPUTER PROMPT***		***SPONTANEOUS TOUCHING***	***POSITIVE AFFECT***
			IMAGE	***SOUND/ SIGN***		
3.11		***Y 'try that one'***				
3.13,14,15,16,16,18			***Y***	***Y***		***smiling***
3.19,20,21,22,23,25,27,29,30			***Y***	***Y***		
3.31,32,33,34,35,37,38,			***Y***	***Y***		***smile***
3.40,41,42,43,44,45,46,47,48,49,			***Y***	***Y***		
3.50,51,52,53,54,55,56,57,58,59			***Y***	***Y***		
4.0,01,02,03,04,05,06,07,08,09			***Y***	***Y***		
4.10,11,12,13			***Y***	***Y***		
4.14,15,17,18,19			***Y***	***Y***		***Smile at teacher***
4.20,21,22,23,24,25,27,2829			***Y***	***y***		
4.32,33,34,35,36,37,38,39			***y***	***y***		

Coding screen 1 / 2…………….

CHILD: TD5 Typically Developing (TD) **SOFTWARE:** Speaking for Myself (FM)

3 – STRESS/BOREDOM INDEX *(CHILD DISPLAY ANY OF THE FOLLOWING BEHAVIOURS) – duration event*

EVENT ONSET	***EVENT OFFSET***	***FLAPPING HANDS/ COVERING EAR WITH HAND /OTHER REPETITIVE HAND MOVEMENT***	***CONTINUOUS VOCALISISNG***	***NEGATIVE AFFECT***
1.03	***1.05 / 1.06***		*Complained ('what is wrong with it')*	
3.07 3.08 / 1.09			*Complained ('say baby'*	

Coding screen 1 / 2…………….

Child signed at 4.08 but this was discount as it was too short and it was not a complaint or discomfort.

Appendix Q

ATTITUDE QUESTIONNAIRE RESULTS

TEACHING ASSISTANT (TA) ATTITUDE RESULTS

SUMMARY OF ATTITUDE QUESTIONNAIRE RESULTS FOR THE "SPEAKING FOR MYSELF" COMPUTER PROGRAM (FM)

Questions	**Ta1 score**	**Ta2 scores**
1. The program is easy to learn	4	3
2. The program is easy to use.	4	3
3. The program is easy to adapt/ change (as the need may arise).	0	3
4. The program can be used for purposes beyond those for which it was created.	3	3
5. The program is easy to explore using trial and error methods.	3	3
6. The program responds at a reasonable speed.	3	3
7. The instructions on the computer screen are easy to read.	3	3
8. The information on the screen is well structured.	3	3
9. The instructions in the program are clear.	3	3
10. The colour scheme used on the interface is adequate.	4	3
11. The font size used on the interface is appropriate.	4	3
12. The animation used on the interface is adequate.	2	2
13. The graphics used on the interface are adequate.	3	3
14. The words on the screen are easy to understand	4	3
The feedback provided is adequate.	2	3
The words introduced are at the appropriate level for the pupil.	3	3
The program provides sufficient information such as table of content and instructions.	3	3
The program provides facilities to help you assess the structure of the program.	0	3
Additional positive based questions; questions 19-21 in section below		
The program would motivate the pupil.	3	3
The program is effective at maintaining the attention of the pupil.	2	3
The program would help children with ASD learn to read	2	3
The program is effective and useable.	3	3

In questions/statements 1-18 and questions/statements 22-25, the responses were graded using the ordinal scale, whereby the responses recorded in each score was ranked as follows:

4 = strongly agree

3 = agree

2 = disagree

1 = strongly disagree

0= don't know

(Where 4 represents the highest score and 1 the lowest score).

Question/statements 19 -21

Questions/statements	**Ta1 score**	**Ta2 scores**
19. It is difficult to find your way around the program.	3	3
20.It is difficult to return to a page viewed previously	3	2
21. You feel lost, when using the program	3	2

In questions/statements 19-21 the grade for the questions/statements were reversed. Where:

1 = strongly agree

2 = agree

3= disagree

4 = strongly disagree

0= don't know

(Where 1 represents the highest positive score and 4 the lowest score).

SUMMARY OF ATTITUDE QUESTIONNAIRE FOR THE "SENTENCE MASTER" COMPUTER PROGRAM (SM)

Questions/statements	**Ta1 score**	**Ta2 scores**
The program is easy to learn	4	3
The program is easy to use.	4	3
The program is easy to adapt/change (as the need may arise).	0	3
The program can be used for purposes beyond those for which it was created.	3	3
The program is easy to explore using trial and error methods.	3	3
The program responds at a reasonable speed.	2	3
The instructions on the computer screen are easy to read.	3	3
The information on the screen is well structured.	2	3
The instructions in the program are clear.	3	3
The colour scheme used on the interface is adequate.	4	3
The font size used on the interface is appropriate.	4	3
The animation used on the interface is adequate.	2	3
The graphics used on the interface are adequate.	3	3
The words on the screen are easy to understand	4	3
The feedback provided is adequate.	2	3
The words introduced are at the appropriate level for the pupil.	3	3
The program provides sufficient information such as table of content and instructions.	2	3
The program provides facilities to help you assess the structure of the program.	3	3

Questions/statements	Ta1 score	Ta2 scores
Positive based questions/statements; questions/statements 19-21 in section below		
The program would motivate the pupil.	2	2
The program is effective at maintaining the attention of the pupil.	2	2
The program would help children with ASD learn to read	3	3
The program is effective and useable.	3	3

In questions/statements 1-18 and questions/statements 22-25, the responses were graded as follows:

4 strongly agree = positive

1 strongly disagree = negative

Where 4 represent the highest score (positive score) and 1 the lowest score (negative score).

Question 19 -21

Table 4 Attitude questionnaire results (Sentence Master)(b)

Questions/statements	Ta1 score	Ta2 scores
19. It is difficult to find your way around the program.	3	2
20.It is difficult to return to a page viewed previously	3	2
21.You feel lost, when using the program	3	3

In questions/statements 19-21, the grades for the questions/statements were reversed.

Where:

1 strongly agree = positive

4 strongly disagree = negative

Where 1 represents a positive highest score (positive score) and 4 the lowest (negative score).

HUMAN COMPUTER INTERACTION PROFESSIONALS (HC) ATTITUDE RESULTS

SUMMARY OF ATTITUDE QUESTIONNAIRE RESULTS FOR THE “SPEAKING FOR MYSELF” COMPUTER PROGRAM (FM)

Questions	HC1 score	HC2 scores
1. The program is easy to learn	3	2
2. The program is easy to use.	3	3
3. The program is easy to adapt/ change (as the need may arise).	0	0
4. The program can be used for purposes beyond those for which it was created.	0	3
5. The program is easy to explore using trial and error methods.	4	2
6. The program responds at a reasonable speed.	4	4
7. The feedback provided is adequate.	2	1
8. The instructions on the computer screen are easy to read.	2	2
9. The information on the screen is well structured.	3	1

Questions	HC1 score	HC2 scores
10. The instructions in the program are clear.	2	2
11. The colour scheme used on the interface is adequate.	3	0
12. The font size used on the interface is appropriate.	3 & 2	2
13. The animation used on the interface is adequate.	3	3
14. The graphics used on the interface are adequate.	4	2
15. The words on the screen are easy to understand	3 (he ask ed ? by whom)	4
The feedback provided is adequate (this question is moved in this part/ aspect of the study to question 7).		
16. The words introduced are at the appropriate level for the pupil.	0	0
17. The program provides sufficient information such as table of content and instructions.	3	2
18. The program provides facilities to help you assess the structure of the program.	3	0

Additional positive based questions; (note questions 19-21 in table --- below)

Questions	HC1 score	HC2 scores
22. The program would motivate the pupil.	3	3
23. The program will be effective at sustaining /maintaining the attention of the child using the program.	3 (not necessary on the right thing)	0
24. The program would help children with ASD learn to read	0	0
25. The program is effective and useable.	3	0

In questions/statements 1-18 and questions/statements 22-25, the responses were graded using the ordinal scale, whereby the responses recorded in each score was ranked as follows:

4 = strongly agree

3 = agree

2 = disagree

1 = strongly disagree

0= don't know

(Where 4 represents the highest score and 1 the lowest score).

Question/statements 19 -21

Table 2 Attitude questionnaire results (Speaking for Myself)(b)

Questions/statements	**HC1 score**	**HC2 scores**
19. It is difficult to find your way around the program.	0	1
20. It is difficult to return to a page viewed previously	4	1
21. You feel lost, when using the program	3	1

In questions/statements 19-21 the grade for the questions/statements were reversed. Where:

1 = strongly agree

2 = agree

3= disagree

4 = strongly disagree

0= don't know

(Where 1 represents the highest positive score and 4 the lowest score).

SUMMARY OF ATTITUDE QUESTIONNAIRE FOR THE "SENTENCE MASTER" COMPUTER PROGRAM (SM)

Questions/statements	**HC1 score**	**HC2 scores**
1. The program is easy to learn	3	3
2. The program is easy to use.	2	4
3. The program is easy to adapt/change (as the need may arise).	0	0
4. The program can be used for purposes beyond those for which it was created.	0	3
5. The program is easy to explore using trial and error methods.	2	3
6. The program responds at a reasonable speed.	2	4
7. The feedback provided is adequate.	0 (for what)	0
8. The instructions on the computer screen are easy to read.	4	4
9. The information on the screen is well structured.	3	4
10. The instructions in the program are clear.	0	3
11. The colour scheme used on the interface is adequate.	3	3
12. The font size used on the interface is appropriate.	4	3
13. The animation used on the interface is adequate.	4	0
14. The graphics used on the interface are adequate.	4	0
15. The words on the screen are easy to understand	4	4
16. The words introduced are at the appropriate level for the pupil.	0	0
17. The program provides sufficient information such as table of content and instructions.	2	0
18. The program provides facilities to help you assess the structure of the program.	1	0

Positive based questions/statements; questions/statements 19-21 in section below

Questions	**HC1 score**	**HC2 scores**
22. The program would motivate the pupil.	0	3
23. The program is effective at maintaining the attention of the pupil.	0	0
24. The program would help children with ASD learn to read	0	3
25. The program is effective and useable.	0	3

In questions/statements 1-18 and questions/statements 22-25, the responses were graded as follows:

4 strongly agree = positive

1 strongly disagree = negative

Where 4 represent the highest score (positive score) and 1 the lowest score (negative score).

Question 19 -21

Table 4 Attitude questionnaire results (Sentence Master)

Questions/statements	**HC1 score**	**HC2 scores**
19. It is difficult to find your way around the program.	2	3
20. It is difficult to return to a page viewed previously	1	0
21. You feel lost, when using the program	2	4

In questions/statements 19-21, the grades for the questions/statements were reversed.

Where:

1 strongly agree = positive

4 strongly disagree = negative

Where 1 represents a positive highest score (positive score) and 4 the lowest (negative score).

GUIDELINES TO SELECTING APPROPRIATE LITERACY EDUCATIONAL COMPUTER PROGRAMS FOR CHILDREN WITH AUTISM

Marian Tuedor
Middlesex University
Hendon Campus
The Burroughs
Hendon NW4 4BT UK
Email: m.tuedor@mdx.ac.uk

Introduction

This paper describes part of a research project that investigates if educational computer programs can be used to reinforce early reading skills in children with autism. One of the main tasks in the study is the identification of programs to be utilized as intervention medium in the study. Failing to identify a set of guidelines to help the process, a model and a set of guidelines were developed.

Autistic Spectrum Disorder (ASD)

The syndrome sometimes known as infantile autism or childhood autism or classic autism or Autistic Spectrum Disorder (ASD) or simply autism, is a term used to describe a disorder that is characterized by a triad of impairments, these consist of communication problems, imagination problems and problems with socialization (Wing 1996).

The use of computer programs can help to support and promote learning in children with autism.
Computer technology fascinates autistic children and has been used to promote the acquisition of various facets of learning, communication and social skills (William et al 2002, Moore and Calvert 2000, Chen and Bernard-Opitz 1993, Heimann et al, 1993(a) & (b), 1995).

Although there are extensive studies enumerating the benefits of computer-based Pagel
Tuedor learning at promoting various aspects of early reading, learning and social skills, there are no guidelines to facilitate the selection of appropriate program for autistic children. Many of the studies to date discuss the programs utilized in each study without giving an indication of ways of selecting appropriate programs. These would assist professionals and parents or guardian of autistic children to select good computer
programs that will assist learning and the acquisition of early reading skills.

Methods

The methods employed in this study include interviews with professionals; a teacher and a
communication assistant of autistic children, and a Human Interaction expert (HcI). It also reviewed three evaluation method methods; Heuristic (Nielsen, 1994), simplex 2 model (Adams, 2005, Adams and

Langdon 2003), the Rare Event Theory (REL) theory (Nelson and Tjus, 1997, Nelson et al, 2001). Other sources that were employed in the design of the model and set of guidelines were derived from literature which include, the Alliance for Technology Access (2000), Segers, Ve—hoven 2002, William et al 2002, Parents let's unite for Kids (PLUK), 2000).

Results and discussion

This paper discusses the formation of a selection model and subsequently, a set of guidelines to facilitate the selection of appropriate educational programs that will reinforce learning and early reading skills in autistic children. The model (and guidelines) proposed involves the converging of various aspects of learning, taking into consideration the issues of literacy, learning, autism, learning disabilities, psychology and Human Computer Interaction (HcI). It is anticipated that this model and guidelines will serve as a model and a set of guides for future selection of educational computer programs that would be used to facilitate various aspects of learning and the articulation of early reading skills in children with autism.

The model is divided into five sections or sets of criteria which are subdivided into questions which the reviewer of any computer program needs to answer to determine if the program being considered meets the need of the targeted user/s.
Criterion 1 (Goal of using technology/ learning objectives)
Criterion 2 (Program content and usability)
Criterion 3 (skills of user/ learning style)
Criterion 4 (Psychological issues; memory and perception)
Criterion 5 (Communication issues and assistive technology)

Diagram 1: Program selection Model for Autism
in view that there were no pre-existing methods or techniques of evolving this model and set of guidelines, the author had to rely on borrowed methods from various subjects that were crucial to learning and autism. Various issues that surround the study range from the learning style of autism, the objectives of the proposed user/s of the technology and practical issues such as logistics, past experience and a repertoire of different options, these may come in to play when using technology to reinforce learning were deliberated upon in the development of this model. in order to reflect the learning needs of people with autism and to provide these individuals with the opportunity to benefit from computer technology.

Conclusion

This paper provides a foundation for more research into providing guidelines to assist professionals, parents and guardians of autistic children in the selection of appropriate computer program to reinforce learning. Further application of this model and set of guidelines is necessary to refine this model to include other areas of learning, education and other forms of learning disabilities. The significant of this paper is the development of a "made to measure" set of guiding principles that will serve as a first stop for researchers, professionals in autism and parents/guardians of autistic children wanting assistance in the selection of appropriate computer programs.

References

Adams. R (2005). Natural Computing. Natural Computing and Interactive System Design.
A. R. Harlow, Essex, Pearson Custom Publishing.

Adams. R and Langdon P (2003). "Simplex: Simple User Check—model for Inclusive Design." Universal Access in HG Inclusive Design in the Information Society: 13-17.

Alcade, N., Marchena and Ruiz. (1998). "Acquisition of Basic Concepts by Children with Intellectual Disabilities Using a Computer-Assisted Learning Approach."

Chen S.H.A and Bernard-Opitz V (1993). "Comparison of Personal and Computer-Assisted Instruction for Children with Autism." American Association on Mental Retardation 31(6):
368-376.

Heimann .M, T. T., Nelson.K.E (a), (1993). Multimedia Facilitation of Communication Skills in
Children with Various Handicaps, The DELTAMessage project. 2002.

Heimann M, N. K. E., Gillberg C and Karnevik M(a), (1993).
" Facilitating Language Skills Through Interactive Micro-computer Instructions: Observation on Seven Children with Autism." Scand Journal Log Phon 18: 3-8.

Heimann. M, N. K. E., Tjus .T, and Gillberg C. (1995). "Increasing Reading and Communication Skills in Children with Autism Through an Interactive Multimedia Computer Program." Journal of Autism and Development Disorder vol. 25(5): p.461-480.

Moore, M. A. C. S. (2000). "Brief Report: Vocabulary Acquisition for Children with Autism
Teacher or Computer Instruction." Journal of Autism & Developmental Disorder 30:359-362.

Murray D.K.C (1997). Autism and Information Technology: Therapy with Computers. Autism and
Learning; A Guide to Good Practice. S. A. J. R. Powell. London, David Fulton Publishers.

National Autistic Society Introduction to Professionals, National Autistic Society, 2004.

National Institute of Mental Health (2004). Autism Spectrum Disorders Research at the National
Institute of Mental Health,. National Institute of Mental Health, 2004.

Nelson K.E, H. M., Tjus T, (1997). Theoretical and Applied Insight from Multimedia
Facilitation of Communication Skills in Children with Autism, Deaf Children, and Children with Other Disabilities. Communication and Language Acquisition Discoveries From a Typical Development, A. L. B. A. R. M.A, Brookes.

Nelson K.E, W. J. M., Camarata S.M, Tjus T, Heimann M, (2001). A Rare Event Transactional Model of Tricky Mix Conditions Contributing to Language Acquisition and Varied Communicative Delays. Children's Language. K. A. Nelson K.E, Johnson C, HillDale.

Nielsen, J. A. M., R.L (1994). Usability Inspection Methods. New York, John Wiley & Sons.
Parents Let's Unite for Kids (PLUK) (2000). Family Guide to Assistive Technology, Parents, Let's Unite for Kids (PLUK), 2004.

Stokes, S. (1999). Assistive Technology for Children with Autism, Strokes S., CESA
7.

Sutherland P (1992). Cognitive Development Today. London, Sage Publication.

The Alliance for Technology Access (2000). Computer and Web Resources for People
with Disabilities, A Guide to Exploring Today's Assistive Technology. USA, Hunter House
Publishers.

Tjus, T. H., M: Nelson. (1998). "Gains in Literacy Through the Use of Specially
Developed Multimedia Computer Strategy." Sage publications 2 (2):139-156.

Williams C. Callaghan, B. C. B. (2002). "Do Children with Autism Learn to Read More Readily by
Computer Assisted Instruction or Traditional Book Methods?" Sage publication and the National
Autistic Society. 6(1):71-91.

Wing L, Ed. (1996). The Autistic Spectrum. London, Constable Press.

Go to previous article
Go to next article
Return to 2006 Table of Contents

Univ Access Inf Soc (2006) 5: 292–298
DOI 10.1007/s10209-006-0047-7

LONG PAPER

Marian Tuedor

Universal access through accessible computer educational programs to develop the reading skills of children with autistic spectrum disorders

Published online: 4 August 2006

Abstract Finding the right research design, method and methodology for research in universal access can be a daunting process, as there are often no clearly laid down procedures on how to go about such work (Adams andLangdon, Universal access in HCI inclusive design in the information society. Lawrence Erlbaum, Mahwah, 2003). Researchers in the past have looked to other disciplines for guidance, or have followed the examples of other leading researchers. This problem is particularly acute when considering groups of individuals with very demanding and complex requirements. This paper evaluates research aimed at enabling children with autistic spectrum disorders (ASD) and severe learning difficulties to acquire early reading skills. In order to carry out research in this area, which contributes to a better understanding of the issues and to provide practical benefits, new methods are required to be developed on top of existing approaches.

Keywords Accessibility · Universal access · Learning · Usability · Research · Inclusive design · Assistive technology · Children · Autism

1 Introduction

This paper attempts to tackle the problems of research design, methods and methodology, as well as processes and procedures in the field of universal access, for children with autistic spectrum disorders and severe learning difficulties. These children are at an early stage of their development and many are non-linguistic or pre-linguistic. This is a systematic account of an attempt at deriving the research design and methods in the evaluation of the usability, accessibility and effectiveness of computer educational programmes in articulating reading skills in children with autistic spectrum disorders (ASD). The study used research methods and methodology borrowed from social science, combining them with previous research efforts in this arena. This paper discusses the strengths and weaknesses of this endeavour, and serves as a guide for new or experienced researchers looking for procedures on how to do research in this discipline.

The syndrome sometimes known as infantile autism, childhood autism, classic autism, ASD, or simply autism, is a term coined from the Greek word ‘auto’ meaning ‘self’. The pioneers of the investigation of this developmental disorder were Kanner and Asperger, who both independently published the first accounts of this disorder. Autism affects four times more boys than girls, and Asperger syndrome nine times as many boys than girls [19, 20]. The exact cause of this disorder is unknown, but research shows that genetic factors may be one of the causes; autism may be connected with conditions that affect the brain such as maternal rubella, tuberous sclerosis and encephalitis [5]. There is no cure for autism, but with early diagnosis and intervention there is a possibility for a successful life.

People with autism may show significant problems in the areas of cognition, communication and social skills. The common problems shared amongst children with autism include a triad of impairment that consist of communication problems, imagination problems and problems with socialisation [29]. They may have problems making sense of the world (perception problems), which they may find confusing. The fact that they have problems understanding feelings and emotion hinders their ability to socialize and communicate. A distinguishing characteristic of autistic children is the inability to understand people and lack of concentration.

1.1 The background to the study

The use of computers has been noted to help to support and promote learning in children with autism. Computer

M. Tuedor
School of Computing Science, Middlesex University,
Trent Park, Bramley Road, N14 4YZ London, UK
E-mail: m.tuedor@mdx.ac.uk

technology fascinates children with autism and has been used to promote the acquisition of various facets of learning, communication and social skills [10, 15–18, 27].

Heimann et al. [15–17] stated that a planned intervention, using computer instructed learning that includes a highly motivating and interactive multimedia environment when teaching children with autism or mixed disabilities (children with cerebral palsy and mental retardation), will improve reading, writing and communication skills.

Moore and Calvert [18] echoed this view and added that computer software can create an interesting and simulating environment for children with autism. These authors noted that carefully developed computer programs could motivate children with autism and promote their learning of vocabulary. They claim that computers are a cost-effective way of educating children who require one to one assistance to learn. There are several studies to date on teaching children with autism various aspects of social and educational skills. Robins et al. [23] used robots in therapy and the education of children with autism, Alcade et al. [3] used computers to teach concepts, and Baron-Cohen [6] used computer programs to teach emotions. However, not enough research is being conducted on the use of computer programs in teaching early reading skills to children with autism.

Heimann et al. [17] investigated the effect of using an interactive and child-initiated microcomputer program (Alpha) when teaching reading and communication skills to three groups of children. This study recorded that children with autism increased both their reading and phonological awareness through the use of the Alpha program. The Alpha program used in that study utilised a multi channel feedback (voice, animation, video and sign language) model to design the system. The benefit of exploring all the varied mediums of learning and communication used in these programs is that it may cater for various degrees of autism. This study concludes that the intervention of a motivating multimedia program might stimulate reading and communication in children with various developmental disabilities. It warns that such interventions must be individually based and include both detailed planning and monitoring from teachers and parents, as well as from the clinicians in charge. The author stressed that although computer aided instruction (CAI) may be of some benefit for children with autism, it should not be expected to solve all the problems that the children will face.

Williams et al. [27] evaluate the progress of 3–5 year old children with autism in developing reading skills using computer assisted learning and book based learning. This study found that five of the eight children could reliably identify at least three words with the use of CAL. The children with autism spent more time on reading material when they accessed it through a computer and were less resistant to the use of this technology in learning. Alcade et al. [3] evaluated the effectiveness of the software "Let's play with...", an interactive multimedia program that teaches shapes, colours and concepts of body position to children with intellectual disabilities. The study was based on the principles of Gagne instructional design and applied behaviour analysis [3]. One of the strengths of this study is that it examines the learning methods of children with intellectual disabilities. Applied behaviour analysis is rooted in behaviourist psychology paradigm (which emphasises reward) and cognitive psychology theories (the information-processing model of cognition) Adams [2]. Alcade et al. paid some attention to the learning process of the subjects that their study investigates. Significant statistical differences were found between the children taught using the software and those taught using traditional methods (instruction by teachers). This study reaffirms the benefits of computer programs as useful teaching and reinforcement learning tools.

This study tries to understand and remedy some of the problems children with learning difficulties face when they use computer technology to learn. It advocates the Gagne theory of learning used in the design and development of the computer program used in the test. However, the scope of this study (involving all aspects of intellectual disabilities) meant that it did not pay adequate attention to any specific area within the spectrum which ranges from mild to severe disabilities. The author noted that it is important to examine the effectiveness of software, but failed to investigate the appropriate use of programs for specific groups.

The emergence of hypermedia in the classroom, as note by most of the studies above, has assisted in the catapulting of computing technology to every day educational use.

Moore and Calvert [18] explored issues relating to using computer software to teach vocabulary to children with autism. Their aim was to create a program based on behavioural learning principles. The study compared the use of computer software to the use of behavioural programs (teachers). The object labelling drill method was used for the experiment. The authors examined the integration of computers in the classroom to supplement pedagogical practice.

The studies (discussed above) fail to discuss the research method employed in carrying out the studies. The studies enumerated the benefits of computer technology but negate to elaborated on the processes and procedures employed in determining these benefits of technology (or in investigating the study). This study gives an account of one attempt in tackling the problems of choosing the appropriate research approach, in a study that infringes on issues that pertains to Universal Access and human computer interaction (HCI).

Human computer interaction is a heterogeneous and diverse field which draws from an inter-disciplinary collection of subjects including computer science, artificial intelligence, cognitive science, engineering design, cognitive psychology, occupational psychology, sociology and rehabilitation. Its focal point mainly deals with designing computer systems that support people so they can carry out their activities productively and safely [21]. In universal access research, ''consilience'', which is the process whereby disciplines are permitted to draw from methods from diverse subjects [28] is an important concept. This raises the question of whether the process used for selecting the method for a study is systematic and appropriate, or is it based on examples of other researchers or from habits.

1.2 Inclusive design and assistive technology

This study likewise takes into account Inclusive Design and Assistive Technology, as these two topics cannot be divorced from HCI when considering the needs of all the populace. Inclusive design is a general approach to designing in which developers and designers ensure that their products and services address the needs of the widest possible audience, irrespective of age or ability. It promotes user centred design that meets individual needs [1].

According to the Design Council[1] there are two major trends that have driven the growth of Inclusive Design (also known as Design for All and as Universal Design in the USA), the ageing population and the growing movement to integrate disabled people into mainstream society.

Assistive technology is any technology that enables an individual with a learning disability to compensate for specific problems/deficits. It empowers children and adults who have learning disabilities with new abilities to communicate without speech or sight, to manipulate their environment, and to demonstrate cognitive abilities in non-traditional ways [25].

Advances in using assistive technology are achieved when access to technology and services is made available for people with disabilities; enabling people with disabilities to achieve productivity, independence and success in their daily endeavours; according to their needs and interests [4].

1.3 Usability and HCI

Usability, a key concept in HCI, is concerned with making systems easy to learn and use. It is a measure of the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and the attitude of its users toward it. This implies therefore that people who use a product should be able to do so quickly and easily, and should accomplish their tasks.

[1] http://www.designcouncil.info/inclusivedesign,2004

1.4 Inclusive design, usability, effectiveness testing and research design

The focal point of this study is centred on evaluating the use of computer educational software in articulating reading skills in children 5–10 with ASD. It entails conducting usability and effectiveness testing. This study involves complex issues that need careful consideration. Some contentious issues that this research attempts to resolve involve computer effectiveness and usability issues. However, looking around for guides on how to research this topic (that is centred on HCI issues) the researcher was faced with problems in identifying the appropriate method and methodologies.

A number of issues needed to be addressed, including:

- Research methodology (epistemological issues) to use in this study.
- Research methods to adopt.
- Research design/techniques to utilize.

2 Methods

Methods are specific research techniques; these include quantitative or qualitative techniques, for example statistical correspondence, as well as techniques like observation, interviewing, experimentation and audio and video recording [24].

2.1 Qualitative method

This study employed the qualitative approach in combination with some quantitative data collection technique. Qualitative method refers to an approach that produces descriptive data. This approach is principally characterised by obtaining people's written or spoken word and by observing their behaviour [26]. Qualitative study involves advancing the assumptions of qualitative design which entails specific type of strategies, reflecting on the researcher's role in research, discussing data collection, developing recording procedures, identifying data analysis procedures, specifying verification steps, interpreting, and writing the outcome of the research or study [12].

The qualitative method of data collection was employed in this study due to the manageability, reliability and ease in analysing [11].

Benefits of the qualitative approach include:

- It uses an inductive approach; this process seeks to understand patterns from data collected rather than rely on previous theories or hypothesis.
- It is holistic; it looks at people, settings or groups as a whole and seeks to understand their personal experiences.

- It is concerned about how people live, their everyday lives and the experiences.
- For qualitative research, all aspects of the research are meaningful and all perspectives are worthy of study.

On the other hand, the qualitative method has been criticized by some for being unreliable because it is not easily cross-checked. It is therefore regarded as biased, selective and personal.

2.2 Research design/techniques

The technique adopted for this research is that of the case study. Dawson [13] describes a case study as a process that involves working on a specific problem or project with a subject or, more usually, an organization, and evaluating the results. It involves the investigation of a particular situation, problem, company or group of companies.

Some benefits of applying the case study method to this study include:

1. Sturman (1999, cited by Cohen et al. [11]) states that the case study methods has an inherent wholeness or integrity, rather than it being a loose connection of traits, and therefore permits a more detailed investigation.
2. It enables the observation of the effect of research in real context (recognising that context is a powerful determinant of both cause and effects).
3. It is a method a researcher could undertake singly without a team of researchers.
4. The data obtained from using this research method is simple and easily understood by a wide audience, as it is written in simple everyday language.
5. Hitchcock and Hughes identified a number of hallmarks in the case study research method (cited by Cohen et al. [11]). They noted that case study methods have the following characteristics:

- They are concerned with a rich and vivid description of events relevant to the case.
- The researcher is given an insight into the real dynamics of situations and people.

3 Procedure

This study is based on the case study approach for evaluating the effectiveness of existing educational interactive multimedia programs in teaching early reading skills in five children with autism aged 5–10. The processes and procedure involved in this study include the identification of programs utilised in the study the pre test, intervention and post test, the reflections on the study's procedures and lastly the analysis of the data obtained.

The main task undertaken in this study involves the identification of programs in the market that is designed to promote early reading skills in children aged 5–10. A number of methods were utilised to identify programs suited for this study, including searches of the web, reviews and articles. Three out of twenty programs were selected for the test using set criteria developed by the researcher.

3.1 The programs utilised in the study

The programs Speaking for Myself [7], Wellington Square and Sentence Master were selected for the study. The program Wellington Square had to be deselected from the study later because the children may have already been exposed to it (as it was a program commonly used in the school). Its use would not have given a valid picture of the success of the program in teaching reading.

The Speaking for Myself program was designed using Director multimedia software with a combination of animations, pictures, images, sound, speech and video clips. It is a program that targets disabled children between the ages of 2–9. Sentence Master Version 2.0 was designed by Blank [9], a developmental psychologist and a specialist in reading and oral language. The program utilises animation, sound, images and speech. This program is repetitive and places emphasis on non-content words.

3.2 Participants

The participants were aged 5–10, nonverbal students at a special needs school where most of the autistic students were part of an autistic unit. The participants had diagnosis of autism and severe learning disabilities. Five participants were involved in the study. All participants were non-readers (they could not read prior to the test). There were two identical tests conducted before (the pre test) and after (the post test) an intervention process. The pre test involved each participant being tested from words extracted from the educational computer program. Symbols from the Widgit 2000 version 2.615 programs were used as a communication aid in the conducting of the tests [30].

3.3 Test

The test was based on the quasi-experimental design, whereby the children were asked to read words before the intervention (pre-test) and after the intervention period (post-test) using symbols. Prior to the test, a pilot test and intervention session was conducted using one subject. This enabled the researcher to try out the research plan and to adapt it accordingly where that was necessary. The duration of the test was

10–15 min. The responses given by the children were recorded and analysed. Two to five words were tested in each session depending on the interest and time span the child could accommodate. A lot of verbal praise was given as a reward and to motivate participants during the test. An object, symbol or word was known when the participant selected the correct answer twice.

The sensitivity of the subjects (the children that participated in the study) was given ample consideration. The test processes and procedures were adapted to accommodate the subjects' needs and disposition (likes and dislikes). For example, the word 'biscuit' was removed from the list of words to be learnt when the researcher learnt that one of the participants disliked biscuits.

3.4 Intervention

The intervention stage involved the participants to learn the words that were tested in the pre test using the computer. These sessions were 10–15 min long. There were eight sessions in total; all participants used the touch screen method, as they were unfamiliar with the mouse. The observation was randomly done mid way through the intervention sessions. The use of two camcorders has already been explained above. The purpose of this exercise was to observe the participants interacting with the computer programs. The research design processes and procedures were carried out conscientiously in order to enable the study to run efficiently with close consideration given to the issues that would promote rigorous prudence in the study.

3.5 Ethical considerations

Ample consideration was given to ethical issues in this study. In planning this study, ethics issues such as consent and the sensitivity of the research topic and the vulnerability of the research subjects were closely deliberated upon. The research ensured that the participants' rights and feelings were given paramount consideration [14]. Informed consent and confidentiality were upheld in this study.

3.6 The limitations of the study

Some of the limitations of this study had to be remedied. These included the problem of implementing the study, the problems of mixed methods, the validity and reliability of data (discussed above in the limitation of the case study method), and generalisation problems (discussed above, in the ethical section of this document). The researcher had to deal with problems in conducting of the test, including amending the test to accommodate the temperaments and disposition of participants. Dealing with last minute amendments to the test schedule made the study difficult. There were accessibility problems and last minute cancellations. There were a few occasions where the site had to be adapted at the last minute due to changes in location or the unavailability of participants at the planned time. Nevertheless, the researcher was able to adapt quickly to such changes and achieved a free flow of test activities. The researcher had to adapt the pre-set questions in the course of an interview, which sometimes-created problems as the structure and content of the interview had to be changed. However, this is beneficial. Since these were semi-structured interviews the questions were only meant to be a guide. Also, it enabled the researcher to explore areas that were not thought of when the interview was created. The interview was conducted in the open area lounge which is located near the main entrance of the building. This was sometime noisy and disruptive as people kept passing the area. Concentration was sometime difficult during the interview, and this created some difficultly when the researcher transcribed the interviews.

3.7 Generalisation of the result findings

Generalisation deals with the degree to which findings may be used beyond the specific situation in which they occur. It refers to the extent to which the findings of an enquiry are more generally applicable to other situations or times.

If the findings of this study would be generalised, this would enable the results of this study to be applied to similar research in this field. Some researchers may criticise this process on the grounds of credibility and over-simplification.

3.8 Practical implication for future research

Finding the right research approach in the designing and implementing of studies that deal with Universal access issues and HCI may benefit from a "made to measure" design approach. This means borrowing from various disciplines. However, there is much gain for researchers in universal access in formulating a research design, which is adaptable, yet grounded in good research and pragmatic approaches that will also accommodate future research in this domain.

4 Discussion

The question whether universal access researchers followed the appropriate approach for a specific study is a constant dilemma. Some of the issues raised are the question of the research methodology adopted and the status of knowledge employed.

Methodology refers to the choices made about cases of study, methods of data collection/gathering, forms data analysis; in the planning and implementing a research [8].

Epistemology is a branch of philosophy that deals with the nature of human knowledge and the processes by which knowledge is acquired [22]. Blaikie [8] described epistemology as the theory of knowledge, which presents a view and justifies what can be regarded as knowledge, what can be known and what such knowledge should be able to satisfy in order to be regarded as knowledge and not beliefs. The research methodology the researcher advocates in this study is a combination of two methodologies, Positivism and Interpretivism. This combination of paradigms would provide this study with two different categories of knowledge, namely objective and subjective knowledge.

4.1 Positivism

This study was designed using the positivist epistemological position. Positivism traces its origin in social science; amongst the prominent Positivists are Comte and Durkheim. Positivists advocate the use of objective knowledge based on absolute reality or facts. The Positivists seek the causes of social phenomena, they belief that facts are separate from subjective individual knowledge [26].

The reason for adopting this methodology is that the researcher sought to find the most appropriate method that would give objective knowledge in conducting the effectiveness testing. This process entails using objective knowledge to determine the effectiveness of educational computer software in enabling early reading skills in children with ASD.

4.2 Interpretivism

Similarly, to obtain a clear perspective, this study also draws from subjective knowledge. The Phenomenologist or Interpretivist position is based on the commitment to understand social phenomena from the perspective of the participants, seeking to experience the world and understand social phenomena from the actors' perspective [26]. The Interpretivist position derives knowledge from every day concepts and meanings, building on the notion that the social world is the world perceived and experienced. The role of knowledge in this context is therefore to discover why people do what they do; this can be done by understanding the mutual knowledge, symbolic meaning, intentions and rules, which provides the interpretation for their actions [8].

According to the Interpretivists all that is possible to know is the meaning of reality, which can be obtained through cultural and historical accounts of events. The Interpretivists seek to understand phenomenon using the qualitative approach such as observation and in-depth interviewing to derive descriptive data. The researcher opted to use this paradigm because it offer this study a clarity that can only be obtained by understanding the reasons underlying the facts obtained from the test data; for example, the researcher could have insight into the children's behaviour, their experience and what factors could contribute to the high or low scores in the evaluation test results. Also, the researcher needed to obtain in-depth understanding of the participants of this research (their skills, abilities, likes and dislikes) and other factors that could influence their ability to learn.

4.3 Problems of mixed methods

Mixing two epistemological positions is not a straightforward process. There is the probability that this process would be criticised for sitting on the fence and not taking any stringent position. Also, there is the danger that such an approach would be criticised by some epistemological camps for not taking a standpoint on the type of knowledge it advocates. For instance, Positivists who advocates absolute knowledge may claim that only objective knowledge based on scientific facts can be known and that everything else is belief. Interpretivists would claim, on the other hand, that only subjective knowledge based on individual experience is knowledge. The practicalities of implementing a test which is free from opinions, views or perspectives may not be, in practice, as viable as it looks. The content of the data collected (the quasi-experiment) will be to some extent influenced by views or perspectives. This is because objectivity and subjectivity cannot be easily separated in practice. There may be a misrepresentation of reality by the data obtained. For example, a child may have scored high grades in the tests on one day, but score low grades in subsequent tests. Utilising interviews (as advocated in this study) may be an effective means of obtaining the views of teachers and clarifying test results. For instance, a drop in a participant's grade may be attributed to the child not having had enough sleep the night before. Thus, objective knowledge was used as a sole medium to obtain data, the validity of the results could be disputed. This example gives further credence to this researcher's position on utilising objective and subjective knowledge based methods of data collection even though it leaves this study open to criticism. Mixed methods give this study a rounded and robust perspective.

4.4 Mixing methodologies and related implication

Mixing Positivist and Interpretivist methodologies could be criticised as been contradictory, conflicting and an unreliable way of obtaining knowledge. However, it could also be viewed as beneficial in the light of the fact that by combining different ways of looking a reality/knowledge (facts and experience) the researcher adopted a complementary approach to the process of obtaining knowledge, thereby giving credence and validity to this study as advocated by Robson [24].

5 Conclusion

This study advocates a combination of research methods and methodology based on borrowing from various disciplines, such as social science, and following the examples of other established HCI research. Given that HCI researchers have little laid-down guidelines on research design, research methods and methodology borrowing from other disciplines with laid down principles in conducting research and years of experience would enable research in HCI obtain a wealth of substance, validity, and credence.

References

1. Adams, R., Langdon, P.:Simplex: simple user check-model for inclusive design. In: Stephanidis C (ed) Universal Access in HCI Inclusive Design in the Information Society, pp 13–17. Lawrence Erlbaum, Mahwah(2003)
2. Adams, R.: Natural Computing Natural Computing and Interactive System Design. Pearson Custom Publishing, A. R. Essex (2005)
3. Alcade, N., Marchena, R.: Acquisition of basic concepts by children with intellectual disabilities using a computer-assisted learning approach. Psychol. Reports **82**, 1051–1056 (1998)
4. Alliance for Technology Access.: Computer and Web Resources for People with Disabilities a Guide to Exploring Today's Assistive Technology. Publishers Press, US (1994)
5. Antonio, R.D.M., Ralph, G., Maurer, M.D.: A neurological model of childhood autism. Arch. Neurol. **35**, 777–785 (1978)
6. Baron-Cohen, S.: MIND READING the Interactive Guide to Emotions. Kingsley Publishers, Jessica (2004)
7. Black, B.: Speaking for Myself. Topologika, Cornwall (1987)
8. Blaikie, N.:Approaches to social enquiry. Blackwell, Cambridge Blackwell (1993)
9. Blank, M.: (1995) The Sentence Master. Winooski
10. Chen, S.H.A., Bernard-Opitz, V.: Comparison of personal and computer-assisted instruction for children with autism. Am. Assoc. Mental Retard. **31**(6), 368–376 (1993)
11. Cohen, L.M.L., Marrison, K.: Research Methods in Education. RoutledgeFalmer, London and New York (2000)
12. Creswell, J.W.: Research Design: Qualitative & Quantitative Approaches. Sage, London (1994)
13. Dawson, C.W.: The Essence of Computing Project a Student's Guide. Pearson, Harlow (2000)
14. Greig, A.D., Taylor, J.: (1999) Doing Research with Children. Sage publication Ltd, London
15. Heimann, M.T.T., Nelson, K.E.: Multimedia Facilitation of Communication Skills in Children with Various Handicaps, The DELTA Message project 2002 (1993)
16. Heimann, M.N.K.E., Gillberg, C., Karnevik, M.: Facilitating Language skills through interactive miro-computer Instructions: observation on seven children with autism. Scand. J. Log. Phon. **18**, 3–8 (1993)
17. Heimann, M.N.K.E., Tjus, T., Gillberg, C.: Increasing reading and communication skills in children with autism through an interactive multimedia computer program. J. Autism Dev. Disord. **25**(5), 461–480 (1995)
18. Moore, M., Calvert, S.: Brief report: vocabulary acquisition for children with autism; teacher or computer instruction. J. Autism Dev. Disord. **30**, 359–362 (2000)
19. National Autistic Society.: Computer application for people with autism. National Autistic Society 2004 (2001)
20. National Autistic Society.: Introduction to Professionals. National Autistic Society (2004)
21. Preece, J.: A guide to usability human factors in computing. Addison-Wesley, Wokingham (1993)
22. Robinson, D., Reed, V.: The A–Z of Social Research Jargon. Ashgate publishing, Aldershot (1998)
23. Robins, B., Dautenhahn, K., Boekhorst, Billard, A.: Robotic assistants in therapy and education of children with autism: can a small humanoid help encourage social interaction skills? Universal access in HCl inclusive design in the information society (UAIS) (2004)
24. Robson, C.:Real World Research, a Resource for Social Scientists and Practitioner–Researchers. Blackwell, Oxford and-Cambridge (2002)
25. Strokes, S.: Assistive Technology for children with Autism, CESA 7 (2002)
26. Taylor, S.J., Bodgan, R.: Introduction to Qualitative Research Methods. Wiley, Chichester (1997)
27. Williams, C., Callaghan, B.C.B.: Do children with autism learn to read more readily by computer assisted instruction or traditional book methods?. Natl. Autistic Soc. **6**(1), 71–91 (2002)
28. Wilson, E.O,: Consilience: the Unity of Knowledge. Abacus, London (1999)
29. Wing, L.: The Autistic Spectrum. Constable Press, London (1996)
30. Writing with Symbols.: Widgit (2000)