The uses of Computer Technology in the Remediation of Children with specific learning difficulties (Dyslexia).

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Abstract

This literature review looks at current thinking and research in relation to the uses of computer technology in aiding children, with specific learning difficulties (dyslexia), gain literacy skills.

It opens by defining what the term "specific learning difficulty" means. It looks at current pen and paper methods of diagnosing specific learning difficulties and contemplates the possible alternative use of the computer in this regard.

It addresses some of the issues in using Computer Technology to help dyslexic children with reading, spelling, writing and mathematics. It looks at the advantages and disadvantages of laptop use in the classroom with children with learning difficulties.

Based on the review of literature and results found in this study, it can be concluded that computer based technology has a role to play in the remediation of children with learning difficulties.

Rationale

Many children seem to "catch" reading, as if it is an innate skill. Often this seems to be in spite of teaching and their teacher! For those children who struggle to attain literacy skills they face a lifetime of misery and failure in an age when information processing and literacy levels are fundamental cornerstones to success.

I have been interested in children's' learning difficulties since I started teaching in 1979, and especially since 1990 when I completed a Certificate in Remedial Reading and Language in St. Patrick's College, Drumcondra. I spent four years at that stage as the Remedial Teacher in my school and was very aware of the struggle children with specific learning difficulties had to attain and sustain literacy levels. Their problems of visual and auditory memory proved very difficult to remediate by conventional remedial techniques such as phonics, word attack skills, "look,cover,write" methods in spellings etc.

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I was most interested to receive a copy of the report "Study of Remedial Education in Irish Primary Schools"(1998) which noted that although fifty three percent of remedial teachers have access to a computer for teaching purposes, 30% of these teachers do not use computers in their teaching because of "lack of time, insufficient knowledge or lack of appropriate software" and furthermore they pointed to long delays between " referral of a pupil for psychological assessment and the completion of that assessment."

Could computer technology help children with specific learning difficulties? What help was available via computers in areas such as reading, spelling , maths and writing for children with specific learning difficulties? Could the computer address the diagnosis of specific learning difficulties? What were the advantages and disadvantages of computer assisted learning?

It was on this basis that I undertook this review. I was amazed at the apparent lack of research undertaken in Ireland regarding computer-assisted learning and specific learning difficulties (dyslexia).

Specific Learning Difficulties (Dyslexia)

Some children seem to learn to read almost without any teaching, believe Reason and Boote (1986). They learn to read so easily and effortlessly that one wonders whether reading is a skill which must be taught and built up by practice .The children we are concerned about in this review often confuse letters or whole words, typically cannot remember a word which has just been read for them, their spellings are bizarre, some struggle to make their handwriting legible. This leads Reason and Boote (1986) to define specific learning difficulties as" poor retention of a reading sight vocabulary and sound/ symbol correspondence. Spelling errors tend to be unconventional because they reflect earlier reading difficulties"

Routledge in "The Basis of Special Needs"(1995) uses the term specific learning difficulties to refer to those children who may have" significant difficulties in reading, writing, spelling or manipulating number which is not typical of their general level of performance. They may demonstrate a high level of ability orally yet may encounter sustained difficulties in gaining literacy or numeracy." Generally dyslexics display an uneven pattern of academic strengths and weaknesses .The child typically may have significant difficulties with sequencing and visual perception as well as visual and auditory discrimination. Routledge (1995) notes that progress is" conspicuously better in some areas of the curriculum than in others".

Singleton (1994) notes that dyslexia effects approximately 4% of the population. Dyslexia, he suggests is a dysfunction of the brain or a difference in the way the brain organises, stores and processes certain types of information. Current research, he argues, indicates that dyslexia is an inherited condition and may have a neurophysiological basis. The problem is compounded further by poor memory. This gives rise, to a host of learning problems, he feels such as:

- Difficulties in forming associations between letters and sounds;
- Remembering sequences of letters for spelling
- Rapid word recognition when reading;
- Maths activities e. g. learning multiplication tables; sequence of operations in different types of calculations

The dyslexic child may have to put tremendous effort into learning something only to find his /her memory fails them. Not surprisingly many dyslexics are extremely reluctant learners.

Computer aided instruction and dyslexia

There are five principal advantages of computer assisted instruction notes Singleton (94);

1. Motivational Value. Interesting varied activities increase time the child is willing to spend practising academic skills. The computer is also an endlessly patient, non-critical teacher
   It can re-motivate the reluctant learner, boosting his/her confidence and giving them the determination to overcome their difficulties. Singleton (92).

2. Individualised instruction; if the computer is programmed in an interactive way it will respond to the pupil, varying speed of presentation and difficulty of material in accordance with the pupils needs and progress.
   Harsh and Repp note that the individualised instruction includes the assessment of prerequisite skills and selection of appropriate responses.
   Lerner suggests that a Computer assisted program is like a personal tutor and since the computer motivates most pupils they will work for longer.

3. Informative feedback: Pupils with learning difficulties have a high need for reward and this can be effectively catered for.
   Immediate reinforcement of correct responses is catered for, note Harsh and Repp, as is corrector procedures for incorrect responses.

4. Active learning environment: The pupil can to a certain extent play an active role in shaping and controlling his own learning experience e.g. word-processing.

5. Precise monitoring: The teacher can maintain a check over the pupil's progress easily and precisely. The computer can be used for diagnostic and assessment purposes.

Effectiveness of CAI

Drill and practice software

Computer aided instruction is particularly effective for drill and practice type learning. This has been criticised as outdated and rigid (Carlson and Silverman (1986), but as Singleton points out the various processes involved in literacy skills requires the execution of different cognitive operations. Such skills cannot be performed well unless they are automated which comes as a result of appropriate and sufficient practice. This is especially the case for children with dyslexia whose memory difficulties require greater amounts of highly structured practice to achieve the same degree of mastery as non-dyslexic children. Drill and practice software provides the repetition they require in order attaining fluency or automaticity of lower order skills (Torgeson 1986).

Content free software

The word processor does not aim to teach anything but it facilitates the writing process in many ways:

- The editing facility aids the dyslexic pupil with the organisation of ideas and structuring of written work.
- The spell checker recognises and helps in the correction of spelling errors.

Ingram (1994) points out that this type of content free software is on the increase in education especially as the hardware becomes more and more powerful, enabling the creation of ever more complex feats of software engineering such as word prediction and speech feedback. The quality of speech has improved dramatically and research evidence now attests to its value for dyslexics in the acquisition of reading skills (Miles 1994)
Problems remain in the classroom however. A talking word processor is an obvious distraction. If the child wears headphones he may not hear the teacher. Should he be withdrawn from the class? This withdrawal is the type of differentiation, which Blamire (1994) denounces.

Reading

Singleton (1992) cites a meta analysis of twelve studies on the effects of computer aided instruction carried out by Roblyer and King (1983), which reported that subjects who have received CAI, on average attained reading scores approximately 2/3 of a standard deviation above control groups, which is a significant gain. The effectiveness of CAI is not due to any "magical" instructional ingredient, Singleton suggests but rather to the fact that it follows sound educational principles: emphasis on mastery learning, direct instruction, structured progression of tasks, individual adaptability and enhanced motivation due to success probability.

Instructional Design

Increasingly, Ingram notes(Trends in Educational Software 1994), the software for CAI is being professionally designed and designed for specific purposes. They are gaining in sophistication. The emphasis is less on making learning fun and more on getting the program to do something useful.
Johnson et al. (1987) note that software programs that provide a cumulative review of learned skills or that mix learned skills with target skills provide better maintenance of those skills.

Learner Type

Results from a study carried out in the University of Tennessee (Erdner et al 1998) suggest that significantly statistical gains were sex specific with only males exhibiting an average increase gain in reading scores when exposed to CAI. They suggest this is because males engage in more computer-related activities than do females outside of school. They further note that CAI is effective in helping "at risk" or "below grade level students learn basic skills such as reading.

Ross and Schulz (1999) suggest that CAI may not be the most appropriate method of learning for all students. In an exploratory study they found that Abstract Random Learners might be at risk of doing poorly with certain forms of CAI. Abstract Random Learners are highly focused, they note, on a world of feelings and emotion. They are spontaneous, person-oriented people.

Diagnosis of Dyslexia

Current pen and pencil methods of diagnosing dyslexia include the Aston Index (Newton and Thomson) and the Bangor Dyslexic Test (Miles 1983) both of which include a set of positive indicators such as:

- Perceptual deficits,
- Left right deficits
- Digit span problems
- Problems reciting months of the year, days of the week
- Tables

The Aston Index is a particularly thorough screening battery of tests, which class teachers can administer, but it is difficult to do so in a class situation.
The Bangor Dyslexia Test takes only ten minutes to administer but requires clinical judgement to derive a score.
Both tests are now over a decade old.
The other approach to diagnosing dyslexia is to utilise the skills of an educational psychologist. The delay for such diagnosis can often be eighteen months. As Singleton says "Using educational psychologist to confirm suspicions is costly in terms of time and expense.

The possibility of developing a test that could predict the failure to achieve reading ability before that failure manifested itself would clearly be extremely advantageous for the teacher, parent and especially the child.
Typically as Singleton (94) points out a child with dyslexia is not diagnosed until relatively late in his/her school career (9-12) years.
"Computer based remediation can be an extremely efficient tool in the armoury of the teacher charged with this responsibility Waiting for a child to fail, with all the misery and loss of motivation which it entails, is not an acceptable way of dealing with a condition which can be identified in most cases on school entry Singleton (94)

Fawcett and Nicolson (94) point out "the earlier a diagnosis is made the greater the opportunity to break into the cycle of failure and demotivation which is associated with dyslexia"

A study conducted by Nicolson, Fawcett, Moss, Nicolson M, and Reason (99) sought to develop and evaluate an intervention strategy for children at risk of reading failure in the first year of school.
The primary aim of the study was to assess the cost-effectiveness of the "Interactive Assessment and Teaching approach" approach to helping children learn to read in small groups. The approach proved highly effective, accelerating 40 of the 62 children to reading on the 90th percentile or better for their age. It also proved to be highly cost effective. Around one quarter of the trained group remained" problem readers ", however. The likelihood of being a problem reader was greater for older children, and children with high scores on the Dyslexia Early Screening Test (DEST).

The report concluded that the three stages of intervention strategy are promising i.e.

(i) children at risk of reading failure are identified before six years
(ii) at risk children are given a small group intervention program for three to four months;
(iii) children still failing to make progress may then be given targeted additional support.

An intensive longitudinal study of reading development cited in Singleton (94)(Ellis and Large 1987) revealed that only three variables out of a total of forty four reliably differentiated children with specific reading difficulties from their better reading peers.
They were

1. Short term memory
2. Phonological segmentation(e.g. ability to detect rhyme and alliteration)
3. Reading vocabulary

Singleton questions whether the short-term memory deficit in dyslexia is "essentially one of capacity or one of processing" and he concludes that
" There does not seem to be a general short term memory deficit in dyslexia children at all, for it is only in memory tasks which involve verbal coding and /or rapid sequential processing that most dyslexia seem to be at a disadvantage"

Recent research shows that phoneme awareness is limited in young children. It arises as a result of learning to read rather than reading to learn (Tumner and Nesdale (85)
Singleton notes that there is now a substantial body of evidence that phonological awareness predicts reading development independently of IQ and social background. Children with these difficulties are more likely to have subsequent problems in learning to read and spell.

Use of Computer application in cognitive assessment

Current research is showing how the computer can be a valuable tool in early identification of dyslexia. The precision, objectivity and flexibility of the computer make it an ideal tool for assessing cognitive abilities…. It displays a degree of accuracy which is many times better than that shown by a human experimenter using a stopwatch (Singleton (94))
However its use must extend beyond the stage of simply translating pencil- and -paper psychological tests to the computer so that it becomes merely a labour saving device.
In 1990 the Reading Research Laboratory of the Psychology Department at the University of Hull developed an interactive program for assessing impairments in associative memory. The research at Hull concluded that reliable techniques based on detection of underlying cognitive deficits promise much earlier diagnosis of the dyslexic than was hitherto possible.

Singleton notes that "early detection is surely preferable to a policy of waiting for the child to fail with concomitant suffering and loss of motivation" Singleton (94)

The research team at Hull under the directorship of Dr. Chris Singleton has developed a computerised 'baseline ' assessment scheme, which has now been accredited for use in schools in Great Britain by the National Qualifications and Curriculum Authority.
This scheme enables teachers to make an accurate assessment of the basic skills of new pupils in a matter of minutes and it is also fun for young people to use. The results are calculated immediately and reports on each child can be printed out at the touch of a button. The computer will even print out a special report for a parent that is written in jargon free language.
The system CoPs (Cognitive Profiling System) was originally developed during 1996 contains nine computer games and assesses the visual, verbal and memory skills of the child. The games feature colourful graphics and high-quality digitised speech. Many of the games are linked by 'Zoid' an engaging character who children find it great fun to work with. Each game assesses a different element of the child's cognitive skills. Nearly 400 children at 28 primary schools were involved in the research.
The present version CopS Baseline was trailed and validated in 1997 and comprises four modules for assessing communication, literacy, mathematics and personal and social development. The Research team under Dr. Singleton is currently (1999) preparing a paper for publication about the trials and methodology used in the research.

Fawcett and Nicolson (1994) are also engaged in research in the computer-based diagnosis of dyslexia. Dyslexia is normally identified by a discrepancy between reading age and chronological age and this they note is not possible until the age of seven or eight.
In practice many children have reached the age of ten before they are diagnosed. Useful predictive tests must be based on two stages: firstly a "post hoc " analysis of the range of deficits which have been identified in dyslexic children; and secondly the application of selected tests to further groups of "at risk" children in order to assess their predictive power. Diagnosis remains high cost in terms of both time and money, because it is restricted to educational psychologists, whose resources are seriously over strained.
These issues prompted the authors to devise the COMB (Combined Operations Multimedia Battery) for the diagnosis of dyslexia. Dyslexic children have difficulties with phonological material e.g. detection of rhymes and ability to segment words into syllables and phonemes. Recent developments in digitised speech allow such tests to be administered by computer, with the computer storing and "speaking " the material.
Dyslexic children also have slower reaction times and the computer is a natural for any type of reaction time study. Potentially other tests such as memory span and the ability to repeat non-words are feasible with computer presentation.

A battery of thirty-one tests was developed. These tests included tests of memory, phonological skill, motor skill, processing sped, psychometric tests, physiological thresholds, and learning ability .The quality of these multimedia tests is high, with timing accurate to 50 ms and with sound quality at least as good as audiocassette. The major drawback, which remains, is that the software requires substantial memory if they use digitised sound and also initial authoring costs are high.
The authors feel they are now in a position to claim that it is possible to create a corresponding multimedia version for many psychological tests which

1. Has near identical procedures and should be as valid as the original ;
2. Has completely standardised procedures,and more reliability
3. Is completely objective ;
4. Normally takes less time to administer;
5. Is more easily administered and needs less highly trained administers ;
6. Is less susceptible to errors of administration, scoring or record keeping.

The DEST Study

Fawcett and Nicolson (94) have also conducted a longitudinal study using computer bases multimedia tests where possible. They selected a panel of around one hundred children aged around four and a half years, plus forty at risk children with a family history of dyslexia.
They administered a battery of tests to the panel, then again after a year and then after two years. Then using the standardised tests for dyslexia, they determined those children who would be diagnosed as dyslexic at six and half years. This allowed them to determine which items of battery are the best predictors of dyslexia, construct a small, easily administered battery which includes the most predictive tests.

In summary the COMB tests provide a cross section of tests of cognitive performance, which can be used, for a variety of purposes.
The DEST tests are aimed at the early diagnosis of dyslexia.
The Dyslexia research Group at Hull have also developed computer based tests (CoPS), including tests of short term memory and phonological development, to promote the early identification of Dyslexia.

Acquisition of spelling using the computer

For most dyslexics who have overcome the hurdle of learning to read efficiently the remaining obstacle to success continues to be inefficient spelling. This problem is compounded by the irregulatory of the English language. Current pen and pencil methods of remediation with dyslexic children demonstrate that the traditional methods of "look, cover and check" (visual inspection) are ineffective for the acquisition of consistently mis-spelled words. Many dyslexics as Singleton notes (94) a "deficient visual memory process, which has hampered the development of a mental lexicon for spelling"

The computer offers us the opportunity of the use of an in built spell-checker. The performance of these spellcheckers e.g. Correctstar with the type of severe mis-spelling of the type made by dyslexics is not particularly good. Newell and Booth (91) discuss the use of predictive word processors. The program is called " PAL" (Predictive Adaptive Lexicon), and although it was developed for those with physical disability, it has proved to be very useful with those with severe spelling difficulties. The authors note spelling improvements of up to 65% fewer errors when using PAL .The predictive word processor was found to increase the opportunities for children with limited language skills by " developing their written language, boosting their self confidence an giving them a sense of achievement".
Newell and Booth, in a further study, designed a spelling corrector "Speller" which they used in conjunction with PAL. In a sample of 700 spellings errors produced by children in the study "Speller" found the correct word in 85% of cases (this compares with 50% of a commercially produced spelling helper). The "Speller" program correctly spotted "brot " for brought, "asaswe" for answer and "with "for white.

Fawcett ,Nicolson and Morris have developed the Spellmaster and Selfspell programs .In "Spelling remediation for dyslexic children" they evaluate the potential for CAL (Computer Aided Learning) support for spelling and compare the two methods above of providing that support for dyslexic children. Tests were performed using a pen and paper format. Results show that both post test and delayed post test performances were significantly better than pre-test ($p < .01$) for both Spellmaster and Selfspell. They conclude that
"Multimedia presentation techniques do have the potential to provide outstanding support for dyslexic children, using the immediacy and reinforcing effect of computer presentation with digitised speech available to avoid reliance on textual presentation"

Karsh and Repp, in a conflicting view, cite two studies (Hasselbring and Crossland (81) and Varnhagen and Gerber(84), which compared the administration of the test of written spelling on the computer and on paper. The students took less time on the written test .The authors suggest that letter search time on the computer keyboard may interfere with the actual spelling process. They further noted that computer aided instruction does have the potential of being efficient and cost-effective for the teacher.

Reading

The skills that children must learn in order to read fall broadly in four groups:

- Phonological word analysis
- Rapid sight word recognition
- Fluent word processing of text
- Comprehension

Children with specific learning difficulties have great difficulty with the first three of these of these groups; i.e. they have problems with decoding skills.

Karsh and Repp note that the computer provides the opportunity for practice at reading, which the teacher cannot provide. (1992) Davidson et al concur (1994)" Computers are very good at providing both individualised work and individualised attention" and again" Computers have the potential for helping in the teaching of reading: they have the time to provide large amounts of practice; they can give consistent feed-back"

Karsh and Repp report on studies (Roth and Beck(1984)) where substantial gains were made by dyslexics, in word reading fluency, using a Construct A word program. This CAI program provided drill and practice in forming real words by matching consonants with word endings. The program lasted for twelve weeks and demonstrable gains in sentence construction and generalised fluency were reported.

The use of computer generated speech feedback has proved most useful. Lundberg (95) has noted that students who enjoyed the benefits of computer training with speech feedback gained more in reading and spelling performance compared to students who had access only to conventional special education. Barron ,Lovett and McCabe (1998) used a computer program DECtalk to narrate instruction involving intensive training in identifying whole words or in identifying and blending word segments. Procedures for developing individualised instruction are described. Neurologically impaired dyslexic children trained with this program achieved greater acquisition and transfer of word recognition skill when their training involved segmented rather than whole word feedback.

Davidson and Noyes (1991) note that computers are capable of giving large amounts of consistent practice. They further note that the more practice one has at a skill the more proficient one becomes. There is evidence to suggest that poor readers are getting less practice than good readers, thus compounding their difficulties are, they further stress.
They conducted a study, whose aim was to investigate, whether use of speech software would produce differential gains on tests of sight vocabulary, for children with learning difficulties. The intervention group increased their pre-test score by 36%, on average, and the control group by 26% .So the trend is in favour of the intervention group. The scores for comprehension were not significantly different leading the authors to deduce that this aspect of reading is acquired equally well from the computer and the teacher. Affectively the study reported that the children ranked reading using a

computer as the least worst of activities, reading in front of a group of people was ranked as the worst activity.

Davidson ,Coles, Noyes and Terrell (1994) carried out a pilot study to evaluate the speech software thus far developed. The main questions here were

- Whether the speech is intelligible to children
- Whether speech-feedback accelerated the acquisition of sight vocabulary.

Results show that the computer is only slightly less intelligible than the teacher is. The report suggests that this may have been due to the unfamiliarity of the voice on the machine and to the novelty of listening through headphones.
There was a significant difference in gain between the two groups (Control, and Intervention) on standardised reading test (Gain Mean of 3.3 for the Intervention Group, and a Gain Mean of 1.3 for the Control Group)
There were considerable differences in the scores of individual children (Standard Deviation of 3.7) suggesting to the authors that some children may benefit from the scheme more than others may.

Use of the laptop for dyslexic children

Fairley house is a co-educational day school in London ,for dyslexic children of average or above intelligence. The school offers a full curriculum to children between the ages of six and twelve years; these children attend for a maximum period of two to three years before returning to mainstream schools.
The school uses computers for many purposes and is particularly encouraged by the advantages of the word processor. (These advantages are discussed elsewhere) The teachers at Fairley House noted that as computer usage increased they became aware of the need to help the children become "computer literate" "It was essential that the children were not hindered by inefficient keyboarding skills"
A keyboarding program was field tested in a class of eleven children from 8-10 years of age. Daily lessons of thirty minutes were organised over six weeks. The children were totally immersed in touch typing routines and the "hunt and peck" method was curtailed.
After several lessons a cardboard cover was used to cover the keyboard and children's ' hands. After six weeks all the children showed substantial gains in both accuracy and speed skills. Tests taken eight months after the completion of the program have shown that gains made earlier have not been lost but have in fact continued to advance.

The Fairley House Micro- type touch-typing program was instituted in preparation for use of a word processor. Each child was given a laptop when they finished the course. The TANDY WP_2 was chosen because it was light enough to take home.
The initial short-term goal of the laptop project was to motivate children and enable those with severe handwriting difficulties to keep pace with their classmates in the production of legible written work. The authors felt that with the use of a laptop the child is able to "spend more time on the content of his work…. Lap-tops are ideal for children whose verbal ability is greater than his written performance".
The laptop was used for homework, spelling tests, dictation and random ideas for essays.
The authors concluded that with the introduction of the laptop many advantages have become apparent.

- The increase in self-esteem that the dyslexic child gains from the production of well presented correctly spelled work.
- The child's concentration improves. The screen also seems to have a hypnotic effect on them similar to a TV screen.
- There was a vast increase in the quantity of work produced.

" The use of the lap-top has brought us nearer to a time when the articulate dyslexic once frustrated by his inability to commit his ideas to paper, will be enabled to do so by the word processor which for him will become the preferred writing tool" Scheib and Lillywhite (91)

The use of portable computers was further assessed in a British study in 1994. Seven students (from elementary through college age) with severe learning difficulties (dyslexia) were given the use of portable computers. The study also examined the impact of the machines on pupils' level of independence and the practicalities of using the machines. This report describes the project's objectives and management, criteria for selection of students, and child preparation and set-up.

Use of the computers was analysed in terms of frequency of use and diversity of use. Frequency of use was sometimes limited by the machine weight, as well as by individual child personality and group dynamics. The study found that students improved substantially in their note taking skills, attitudes towards spelling, writing styles, and keyboarding skills. Price (94)

A study of the role of the laptop computer in schools has been completed at Queen's University of Belfast. The study covered the period between September 91- and June 92. Nine schools were involved

- 1 special school
- 1 primary school
- 6 non-selective secondary intake schools
- I grammar school

Each school was asked to identify two classes of pupils of similar ability. One was equipped with portable (laptop) computers and the other acted as a control group (the exception being the special school where no control class could be identified).
The portables used in the study were the Research Machines NB201, the Toshiba T1000SE, and the Apple Powerbook 100.

The research had two fundamental aims:

1. To discover if portable computers could service the statutory information technology needs of the curriculum, cost-effectively and conveniently;
2. To discover if portable computers can contribute to the cognitive and affective development of pupils.

Qualitative research findings

The authors note several problems, which militate against resourcing schools on a one laptop -per -pupil basis. Problems identified included

- Battery door catches and printer port covers becoming detached
- Faulty disk drives
- Screen problems(poor visibility in various lighting conditions)
- Inconsistency and speed of charging of batteries
- Faults in hinge and clamshell closing mechanisms.

Since the curriculum -related use of portable computers is insufficient to justify daily use, it follows that unless teachers espouse information in presenting other aspects of their subject, the cost-effectiveness of the portable is also questioned. On some days the machine was returned home without being unpacked.

The weight of the machine represents a significant problem; weights varied from 5-7 lbs. Furthermore short and variable battery lives necessitate the carrying of battery chargers and adapters
Teachers noted increased fatigue dealing with difficulties at the machine. Single periods of 35 minutes were insufficient to teach an effective lesson and accommodate the setting up and closing down of machines. The printing of pupils' work was identified as a significant problem and one, which could make excessive demands upon teacher time. The need for fast quiet printers with static desktop or portable machines as servers for the disks of pupils was identified.

Cognitive and affective findings

Maths: the control group exhibited a greater gain score The exception was the grammar school.
Science: The experimental group exhibited a greater gain score in science than the control group and significantly so in the selective entry school.
English: For secondary pupils none of the gains were statistically significant. For primary pupils the experimental group significantly outperforms their control counterparts
Affective findings:
Only in English does a greater proportion of the experimental enjoy the subject than is the case for the control group. Access to information technology enhances the perceived real life relevance of all disciplines.

In summary, the contribution of high access to information technology to the cognitive and affective development of pupils is demonstrated to be at best marginal. The study however has limitations. Problems associated with reliability, portability, charging, classroom resourcing and printing militate against a portable machine per child.

Computer aided instruction in Maths and Numeracy with dyslexic pupils.

In "Using computers for numeracy and Mathematics with dyslexic students" Pauline Clayton (1994)points out "Maths is the whole. Numeracy or arithmetic is only a part and often relies heavily on rote learning"
Dyslexics, she continues, may have problems in any of the following specific areas:

- Number recognition
- Reversal of numbers
- Place value
- Pattern recognition
- Sequencing
- Attaching meaning to symbols
- Shape orientation
- Symmetry
- Direction, right and left
- Co-ordinates and charts
- Estimation

Pauline Clayton reviews several software packages and concludes that in purchasing them we must remind ourselves of the skills needed for maths and numeracy and the areas of difficulties that dyslexics encounter. We can then concentrate on programs that reinforce the skills and ease the difficulties.

The Humberside project was designed to do just that and overall it found that those with learning difficulties in maths "need to understand what they are doing and have a reason for doing it"
Hasselbring and Moore (1996) in Developing Mathematical Literacy Through the use of Contextualised Learning Environments "also note that maths is taught in a "decontextualised manner". Their study found that student gains occurred because the materials used focused on the students' everyday use of maths and this facilitated the student's appropriate transfer of their mathematical knowledge to solving everyday problems.

Karsh and Repp() note that " learning disabled students are less proficient than their peers in acquiring basic maths skills and the discrepancy increases with age". They note further the computer can "motivate, increase engagement, provide increased opportunities for individualised instruction, provide immediate reinforcement and feed-back, and provide detailed data about the child's performance"
They cite two studies Watkins and Webb (1981) who found that a learning disabled group who received ten minutes a day on CAI (Math Machine) performed significantly better on both standardised and criterion referenced tests than did a similar group who received traditional classroom instruction in Maths. The components of the CAI Maths program included" individualised instruction, a comprehensive curriculum organised into a hierarchy of skills, a description of learner outcomes, measurements of progress, strategies for placing the child within the curriculum, and a multisensory learning outcome"

The second study they quote is Trifiletti, Frith and Armstrong(1984) who reported that learning disabled students who received 40 minutes of CAI for four months with the Spark-80 Computerised Mathematics System were superior to a similar group of learning disabled students who received a traditional class bases instruction both in "number of maths skills mastered and the fluency of problem solving".

Karsh and Repp further note that CAI has the potential to provide the drill-and practice opportunities "to develop rapid, effortless and errorless recall of basic maths facts" They cite the investigation the effectiveness of a Fast Fact program (Hasselbring et al 1998) and note that after 49 days of instruction the learning disabled group in the CAI program showed a 73% increase in the number of facts recalled from memory. Teacher instruction before CAI drill - and -practice program, they note, is needed for CAI to be effective.

Conclusion

This review sought to address the potential uses of computer technology in aiding children with specific learning difficulties (dyslexia) to gain literacy skills.

The review looked at current thinking and literature in relation to computer technology and its uses in reading, spelling ,writing and maths.

It explored Computer Aided Instruction and dyslexia and found that CAI is particularly effective for

- Motivating students
- Providing individual instruction
- For giving informative feedback
- Precise monitoring for teachers.

The review looked at software uses and found that computers are useful for

- Drill and practice type activities in Maths and English
- Content free activities e. g. word processing
- Spelling acquisition

The review addressed the issues involved in the diagnosis of dyslexia and looked at the ways computers can aid in the early identification and assessment of dyslexia in systems such as CoPs

The uses of laptops in helping dyslexic children was reviewed and both positive (Fairley House) and negative (Queens University Belfast) positions were noted.

My initial interest in carrying out this literature review was triggered by the fact noted in "Study of Remedial Education in Ireland" that currently only 20% of a possible 53% of remedial teachers with computer access, use the computer in their teaching. Following my literature review it is my opinion that may be due to insufficient knowledge of appropriate software. I further note the apparent absence of any substantial research, in the uses of computer technology ,in Irish schools, with regard to remedial education.

In conclusion , computer technology does have a place in the remediation of children with specific learning difficulties. It can provide a valuable aid to the teacher and help significantly to give those experiencing difficulties in the basic skills, a better start , thus achieving the independence ,confidence and personal wellbeing that effective literacy brings.

Bibliography

1. Barron, R., Lovett,M.,W., Mc Cabe ,R., 1998 Using talking computers to remediate reading and spelling disabilities: The critical role of the print to sound unit. *Behaviour Research Methods Instruments and Computers*, Vol.30, (4) 610-616.

2. Blamires, M., Differentiation, I.T., mainstreaming and dyslexia: Which one is the odd one out? In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology. Dyslexia* Computer Resource Centre: University of Hull, 37-47.

3. Carlson,S.A., and Silverman,R 1986 Microcomputers and Computer Assisted Instruction in special classrooms: Do we need the teacher? *Learning Disability Quarterly* (9) 105-110.

4.Clayton, P., 1994 Using Computers for Numeracy and Mathematics with Dyslexic Students In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology .*Dyslexia Computer Resource Centre :University of Hull, 154-161.

5.Davidson, J., Coles, D., Noyes, P., Terrell,C.1991. Books that talk. In Singleton, C.H. ed. *Computers and Literacy Skills* Dyslexia Resource Centre, University of Hull 75-85.

6.Davidson,J., Noyes, P., 1994 .Computer -Generated Speech Feedback as Support for Reading Instruction . In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology. Dyslexia* Computer Resource Centre: University of Hull, 120-136.

7.Department of Education and Science, 1998. *Study of Remedial Education in Irish Primary Schools* Dublin Educational Research Centre, St., Patrick's College.

8.Erdner,R.A., Guy,R.F., Bush,A., 1998. The impact of a year of computer assisted instruction on the development of first grade learning skills. *Journal of Educational Computing Research* (18) 369-386.

9.Fawcett,A.J., Nicolson ,R.I. and Morris ,S., 1994. Computer -based spelling remediation for dyslexic children *Journal of Computer Assisted learning* (9), 171-183

10.Ingram, E., 1994 Trends in educational software. In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology. Dyslexia* Computer Resource Centre: University of Hull, 17-2.

11.Johnson,G., Gersten,R., and Carnine,D.,1987 Effects of instructional design variables on vocabulary acquisition of LD students: A study of computer assisted instruction. *Journal of Learning Disabilities* (20) 336-341.

12 Karsh,K.G., 1992 Computer Assisted Instruction: Potential and Reality. In Taylor, L,. Sternberg ,L.,eds. *Learning Disabilities: Nature Theory and Treatment*. Springer- Verlag 452-477.

13. Lerner,J,.1997. *Learning Disabilities* 7th ed., U.S.A. Houghton Mifflin Company.

14. Lundberg,I.1995 The Computer as a Tool of Remediation in the Education of Students with reading Disabilities- A Theory based Approach. *Learning Disability Quarterly* Vol.18 (2) 89-99.

15. Miles,M.,1994. The Somerset Talking Computer Project. In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology* .Dyslexia Computer Resource Centre: University of Hull, 99-109.

16. Newell, A.F., Booth, L.,1991. The use of lexical and spelling aids with dyslexics. In Singleton, C.H. ed. *Computers and Literacy Skills* Dyslexia Resource Centre, University of Hull 35-44.

17. Reason,R.,Boote,R. 1986*. Learning Difficulties in Reading and Writing: A Teachers Manual*. England: NFER Nelson.

18. Ross, J., andSchulz,R.,1999 Can computer-aided instruction accommodate all learners equally? *British Journal of Educational Technology* Vol.30(1) 5-24

19. Ross,J., Schulz,R., 1999 Can computer-aided instruction accommodate all learners equally? *British Journal of Educational Technology* Vol. 30(1) 5-24.

20. Scheib,B. Lillywhite,C 1994 Keyboard Skills and Laptop Word Processing. In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology* .Dyslexia Computer Resource Centre :University of Hull, 88-96.

21. Routledge, 1995.*The basics of special needs. Survival guide for classroom teacher.*

22.

20.Sepher ,H and Harris D ,.1995. Teachers' use of software for pupils with specific learning difficulties *Journal of Computer Assisted Learning* (11), 64-71.

23. Singleton ,C., 1994 Computers and dyslexia :implications for policy and practice. In Singleton, C.H.,ed .*Computers and Dyslexia. Educational applications of new technology* .Dyslexia Computer Resource Centre :University of Hull, 6-16

24. Singleton, C., 1991 A rationale for Computer Assisted Literacy Instruction. In Singleton, C.H. ed. *Computers and Literacy Skills* Dyslexia Resource Centre, University of Hull 9-21.

25. Stansfield ,J.,1991. Use of speech with computers for pupils with specific learning difficulties In Singleton, C.H. ed. *Computers and Literacy Skills* Dyslexia Resource Centre, University of Hull 69-73.

26. Torgenson, J.K.,1986 Computers and cognition in reading :a focus on decoding fluency*. Exceptional children* (53) 157-162.