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The effects of the provision of an interactive teaching program and word processors on the writing of year 9 students with learning disabilities

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THE EFFECTS OF THE PROVISION OF AN INTERACTIVE TEACHING PROGRAM AND WORD PROCESSORS ON THE WRITING OF YEAR 9 STUDENTS WITH LEARNING DISABILITIES

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Abstract

Three male year nine students with learning disabilities were given an intervention program that involved use of a word processor to write science fiction stories. The program was conducted over a five-week period. The effects of the use of the word processor alone were compared to the effects of the provision of an interactive teaching course program in conjunction with a word processor. The treatment program was a single subject treatment design. One participant's writing improved to an equal extent whether or not an interactive teaching program was provided. A second participant's fluency, spelling and the number of unique words written improved more if an interactive program that provided feedback were provided than if he used the word processor alone. The mechanics of his writing improved regardless of the provision of an interactive program. The third participant's spelling improved more if an interactive teaching program that provided feedback were provided. The mechanics of his writing improved regardless of the provision of the interactive program.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text. This thesis does not contain material of a defamatory nature.

14th January 2000

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Chapter One

Introduction

This chapter explores the nature of the writing process. This is followed by a discussion of the problems that students with learning disabilities commonly experience when they write. There is a discussion of the possible benefits to students with learning disabilities who use a word processor for writing. Conceptual terms referred to in the body of the report are defined. The aim of the present study was to examine the effects of providing students with learning disabilities with an interactive teaching program in conjunction with the use of a word processor. Finally, a broad outline of the study is presented.

The writing process

Writing is the process of recording language graphically by hand or other means in order to express a meaningful set of ideas (Harris & Hodges, 1995). This definition highlights the two key aspects of writing. It involves both the mechanical process of placing words on paper and the symbolic process of conveying meaning. This implies that writing has a purpose and an audience (even if this is oneself), to whom ideas and information are conveyed.

Writing is a complex form of communication embedded with complex social relationships (Cochran-Smith, 1991). It is not merely a mechanical process. Writing is for a variety of audiences and purposes. The writer usually applies appropriate skills to translate spoken language into the conventions of a written form that is intelligible to the reader (Lamb, 1972). Speech is a precursor to writing and is part of a social situation (Outhred, 1987). Writing, on the other hand, is largely an isolated

activity that is governed by conventions such as spelling, handwriting, punctuation and grammar. Mastering these conventions is difficult for many children. When writing a story or an assignment, much of a child's effort may focus on these mechanical components of writing, rather than on the coordination of ideas and on story development (Outhred, 1987).

According to Heenan (1987), the teaching of writing is usually approached either through a product approach to writing or through a process approach. The product approach to writing is a method of teaching that has been widely accepted in traditional classrooms. In a product-orientated classroom, there is a preoccupation with knowledge acquisition and with mastery of the content of a program. The teacher directs the course of the program, acts as the resource to provide knowledge and answers student questions (Heenan, 1987). The process approach to writing emphasises the learning process itself, rather than knowledge content. The aim of the process approach is to teach learning strategies that encourage the exploration and development of skills at an appropriate level within a meaningful context (Heenan, 1987). In a process-orientated classroom, the writing process is considered to be a process of discovery through language. Writing is seen as an evolving process. Teachers are largely unconcerned with the finished product in the early stages of writing (Heenan, 1987).

A number of process-orientated strategies are commonly used in the classroom to improve writing. Heenan (1987) suggests that children focus on developing skills for five different stages of writing. These stages were pre-writing, a planning stage, the writing process itself, a revision stage and an editing stage. Specific strategies

suggested by Heenan (1987) include information gathering and discussion prior to the writing process, journal writing and copious writing practice, peer conferencing sessions, training in editing skills and discussion of the final published product. Galda, Cullinan and Strickland (1993) advocate the use of writing workshops. A writing workshop is a series of writing lessons where students work together cooperatively. They comment positively on others' writing. The classroom environment is supportive and copious writing practice is provided (Galda, Cullinan & Strickland, 1993). Lamb (1972) emphasised the importance of students developing the habit of proofreading. The teacher in a process-orientated classroom takes a pro-active role, conferencing with the student and providing feedback during the revision and editing stages (Galda, Cullinan & Strickland, 1993).

Teaching strategies in the domain of literature that are product orientated include direct instruction programs emphasizing training in phonics. Phonics training is the term used to describe instructional programs that focus on the relationship between the sounds of speech and their relationship to graphemes (Emmitt & Pollock, 1991). Another product-orientated teaching strategy is the use of the blackboard where sentences are written by the teacher and punctuation modeled (Lamb, 1972). Graves (1991) claimed that meaningful practice is important for students learning to write. Through the strategy of providing meaningful practice and instruction in sound-symbol relationships and in context clues, the conventions of sentence writing may be developed (Graves, 1991). Traditional pen and paper exercises may be used to improve students' spelling. For example, students may be given a list of words that are spelt incorrectly. The students are asked to make corrections (Kamler, Woods, 1987).

With the development of technology and the widespread use of the computer, literacy teaching may be considered in two contexts. The first of these is the regular classroom where students practise writing using pen and paper. The second context is the computer-based classroom (Kamler, Woods, 1987). According to Galda, Cullinan and Strickland (1993), the word processor is a useful adjunct to a process-orientated classroom. Revisions are easily made on the word processor. Written work is readily shared with other students and the teacher, both on the screen itself during the writing process and through printing and publishing the final product. Figure 1 illustrates the different strategies that are commonly employed to teach students to write.

The word processor

A word processor is a software package encased in a computer that can be used by writers to enable them to produce a legible written communication (Cochran-Smith, 1991). The use of the word processor facilitates physical manipulation and revision of text. Copying tasks can be avoided. The initial product is easily revisable on the computer screen. The keyboard is light and responsive to touch and the writer is freed from the tasks of recopying, retyping, cutting and pasting. Because some processes such as production, revision and editing are made much easier, total writing time can be allocated differently. Students may be encouraged to treat their writing as a product that is easy to amend. They may therefore write in order to shape and discover what they have to say. They may also save time and be spared from the physical restraints of writing. Word processing may produce a qualitatively different kind of writing that encourages divergent ideas (Cochran-Smith, 1991).

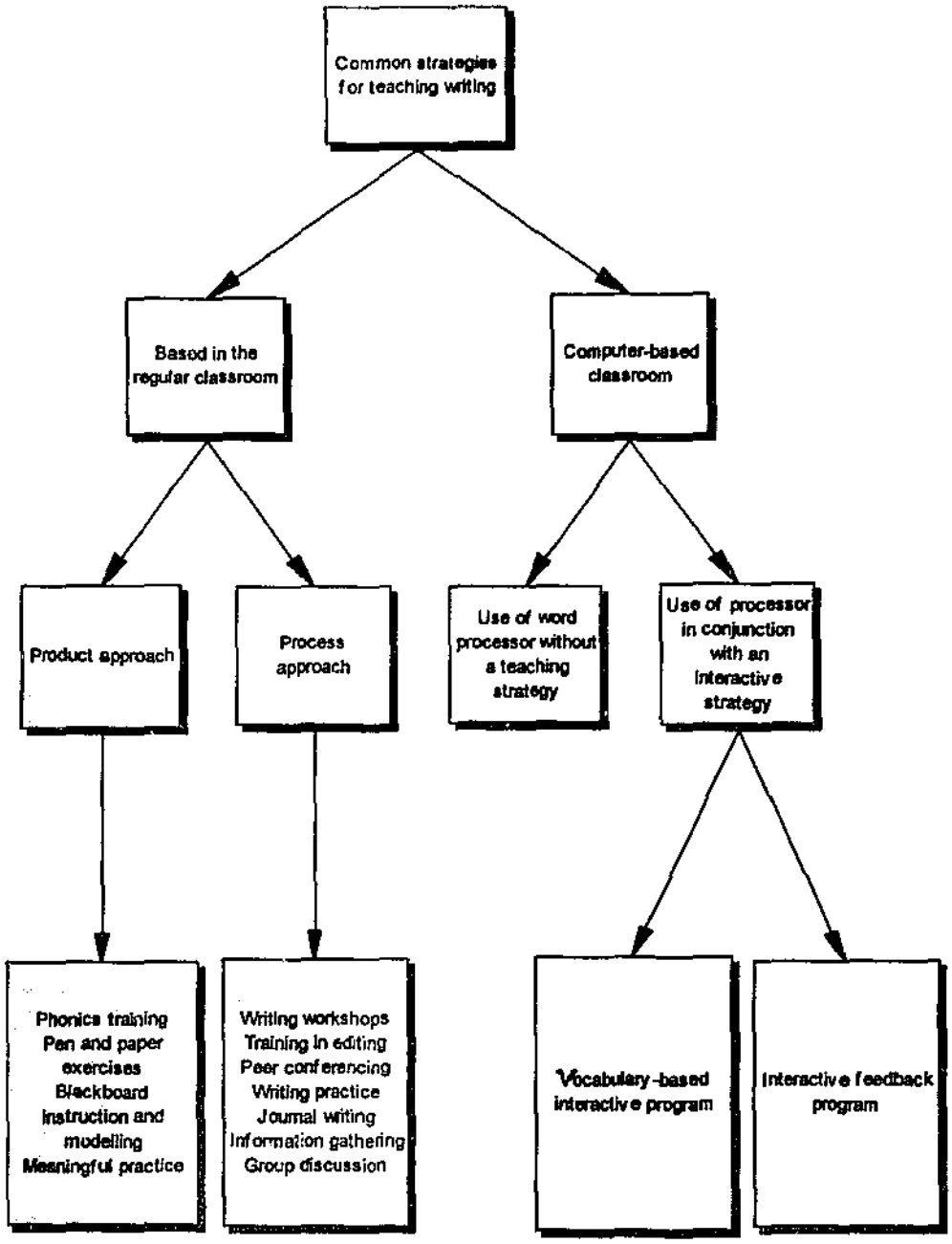

Figure 1. Strategies commonly employed by teachers to teach students to write.

The word processor is increasingly used in the community, in schools and in private and commercial settings. Schools and homes have greater access to this technology as the importance of the new technology is recognized. The word processor has unique qualities that change the nature of the writing process. The body of research has shown that the word processor has a positive effect on children's written work (Outhred, 1987). It visually reinforces the left-to-right and top-to-bottom sequence required in writing. Spatial and coordination skills do not interfere with spacing of words and with the formation of letters. A neat legible final product provokes a positive reaction from the teacher. A word processor produces text that children see as closely resembling words they read. This facilitates the integration of visual and phonological information for these children and helps them to improve their spelling performance. Additionally, children are less likely to reverse letters. They do not have to form the letters but they simply choose the appropriate letter on a keyboard where letters are upper case. Therefore "p" and "q" and "b" and "d" are not mirror images of each other.

Word processing allows the writer to concentrate on personally chosen aspects of the writing processes at any one time. The many tasks of organizing the grammatical constructions, spelling, punctuation and capitalization place heavy demands on the child's cognitive abilities. The writing process overextends some children's limited memory resources. By easing the strain on the working memory, memory resources are freed for higher level thinking processes (Lafrамboise, 1991).

The use of the word processor allows students time to concentrate on ideas, content and on the sequence of thought (Yau, 1991). It facilitates the preparation and revision

of compositions because errors are automatically detected and a neat final product results. Handwriting demands are reduced because staying on the line and letter formation becomes automatic (Majsterek, 1990). Computers relieve the tedious process of recopying, sparing writers with limited skills the negative consequences of writer's cramp. Students are able to produce more text more rapidly (Liechty, 1989).

Using a word processor allows students to produce text that they perceive to be more professional than a handwritten product. Revision becomes an integral part of the writing process and collaborative writing is fostered. The word processor helps students to brainstorm, to edit, to move text and to delete unwanted text. Revision becomes fun and easy. It has a motivational effect on basic writers (Philips, 1995). Word processing allows easy and speedy publishing or multiple copy production of students' writing (Cochran-Smith, 1991).

Most modern word processing packages include a spelling checker facility. A spelling checker is a design feature of a word processing package. Spelling errors in the text are identified. The user easily accesses a range of possible correct responses. A grammar checker is also a feature of many modern word processors. The grammar checker identifies irregularities in punctuation or in sentence structure. Suggestions for correcting grammatical errors are easily accessed by the user.

Measuring the quality of writing

When the quality of writing is measured, either the process or the product of writing may be evaluated. The writing process is comprised of several sequential steps. These steps refer to the planning, production of writing, editing and revising tasks that students undertake when they produce a piece of writing. Lamb (1972) stated that

these processes are difficult to evaluate. Many parts of the process are subjective and introspective. Mental processes are difficult to access and to measure. Lamb (1972) suggested that the product of writing was more accessible and tangible if writing is to be measured.

Bangert-Drowns (1993) has suggested that writing efficiency might be measured in a number of ways. These include the length of the document produced by the writer, the number of syntactic or spelling errors and holistic (total) ratings of writing quality (Bangert-Drowns, 1993). Two measures of writing behaviour that are commonly employed are the amounts of time students spend on the writing task and the number of words written in a composition. This latter measure is referred to as fluency (Liechty, 1989).

Several qualities of writing could serve as measures that indicate that writing has improved (Lamb, 1972). Lamb (1972) has listed minimum requirements that writing should have if it is to serve the function of communicating effectively to an audience. He listed these as being handwriting that is minimally legible, spelling that is at least partially phonetic, a vocabulary adequate to the ideas expressed and some skills of organisation of the ideas so that they are intelligible to the reader (Lamb, 1972).

Writing skills refer to the multiple components of writing that a student masters in order to produce a coherent text that conforms with accepted writing conventions (MacArthur, 1996). Because writing skills are important for academic success in several subject areas, a shortfall in these skills may result in a student being assigned poor grades in a range of subjects. This in turn commonly results in students

becoming disaffected with school in general. Students with problems in writing often struggle year after year with school work, experiencing frustration and failure.

Learning disabilities

A learning disability is a generic term that refers to a condition of children and adolescents who exhibit problems in development and academic skills that are significantly below expectation for their age and ability (Healey, 1996). These disabilities often include severe and prolonged directional confusion, sequencing and short-term retention difficulties and they are presumed to be intrinsic to the individual. The deficits are not considered to result directly from intellectual disability, physical and social defects or emotional difficulties. They do not appear to result from inadequate environmental or educational experiences. The disability may be generalised or may affect more specific areas of learning (Healey, 1996).

Hoy (1993) used USA federal guidelines to define a learning disability in writing as a disorder in written expression of students with average or above average intelligence. The definition stipulated that students score one standard deviation or more below their intellectual level on a standardised achievement test in written language, and that the difference not be attributed to hearing or visual impairment, physical disability or environmental, cultural or economic disadvantage.

Da Fonseca (1996) defined learning disabilities as a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities. These disorders are considered

to be intrinsic to the individual, are presumed to be due to central nervous system dysfunction, and may occur across the life span.

Shean (1993) has stated that the proportion of students with learning disabilities has been widely debated in the literature, largely due to the failure of assessment procedures to identify this student population. For this reason, she avoided the use of the term "learning disabilities" in her report to the Western Australian Ministry of Education (Shean, 1993). Instead she applied the term "learning difficulties". According to Shean (1993), a student with learning difficulties achieves levels in mathematics and/or language that are below specified benchmarks. These results cannot be attributed to intellectual or physical disability, sensory impairment, emotional difficulties, low socio-economic background, geographic isolation, cultural background or lack of appropriate educational experiences.

Because the term "learning disability" is widely used in the relevant literature while the term "learning difficulties" adopted by Shean (1993) is not commonly used by other authors, the more widely used term "learning disability" was used in the present study. Students participating in the present study were identified according to the criteria advanced by Healey (1996). According to these criteria, the participants have experienced problems in development and their academic skills were considerably below expectations for their age and ability (Healey, 1996). Students with learning difficulties commonly experience problems with writing.

Students with learning disabilities commonly experience long-term problems with written expression (Majsterek, 1990). Compositions they produce tend to be brief and

lacking cohesion. These students do not plan effectively and they lack composing and editing strategies. The final products frequently contain more spelling and grammatical errors than do those of normally achieving peers (Majsterek, 1990).

Students with a learning disability often have difficulties with the physical demands and conventions of writing. Many find it hard to coordinate the cognitive processes of setting goals, generating content, organising, evaluating and revising. Revising is an important part of the composing process and effective revision distinguished expert writers from less experienced writers. Students with learning disabilities have a limited conception of revising as being an opportunity to correct errors. Their revisions are restricted primarily to minor changes that do not affect the overall quality of the work (MacArthur, 1996).

Editing is often an overwhelming task for students with learning disabilities who commonly handle it by correcting only a portion of their errors (Dalton, Winbury & Morocco, 1990). Students with a learning disability experience problems with many aspects of the writing process. These extend well beyond the physical demands and conventions of writing. They include setting goals for communication, generating the content, organising the text into a meaningful structure and evaluating and revising their work. The stories that these students write have less developed ideas, are shorter and less coherent than those written by their peers (Bahr, Nelson, & Van Meter, 1996). Students with learning disabilities often find it difficult to complete assignment work legibly and on time (Anderson-Inman, Knox-Quinn & Horney 1996). The consequence is often poor grades and frustration with all forms of schooling.

Students with learning disabilities experience barriers that prevent them from becoming proficient writers (Graves, 1991). Graves (1991) claims that many writers who have experienced failure over a long period of time have diagnosed themselves as poor writers. They become very discouraged and believe that they are unable to improve and therefore do not even try. These students do not see the relevance of writing tasks. They avoid tackling them and instead waste time in class (Graves, 1991). A student who comes to class with a negative learning history may find the learning situation unpleasant and punishing, one the student would rather avoid (Graves 1991). The situation becomes self-perpetuating. Students commonly lack the skills necessary to acquire any sort of fluency. Their negative attitude makes effective learning of the missing skills unlikely (Graves, 1991).

Many students with learning difficulties in writing also experience difficulties with spelling. They have limited phonological awareness (Healey, 1996). The phonological aspects of a language system are the sounds that form the basis of that language (Galda, Cullinan & Strickland, 1993). Phonological awareness is the awareness of the relationship between sounds and the letters that represent them (Galda, Cullinan & Strickland, 1993).

Students with learning disabilities consequently have problems identifying sounds produced by multi-letter units such as "ough". A student with a learning disability frequently uses inconsistent spelling, confuses the order of words and letters within words, cannot "sound" out and confuses letters such as b,d and p,q (Healey, 1996). Students with learning disabilities often misspell two to four times as many words as do normally achieving students (MacArthur, Graham, Haynes & DeLa Paz, 1996).

Their written work typically contains many misspelt words. Their spelling difficulties may also negatively influence teachers' perception of their work. According to MacArthur, Graham, Haynes & DeLa Paz (1996), when students pause to spell a word, they may lose their train of thought, forgetting ideas they have already formulated. Students may limit their vocabulary to avoid spelling more difficult words. Continual struggle with spelling may cause them to terminate their writing, producing short or incomplete papers (MacArthur, Graham, Haynes & DeLa Paz, 1996).

Students with learning disabilities detect and correct fewer of their own errors than do their normally performing peers. The final product is often difficult to read and has a strong negative influence on overall judgments of quality. Despite extensive remediation, these difficulties frequently persist. The production of spelling errors is the most commonly reported problem experienced by adults with learning disabilities. It can prevent full participation in academic and vocational settings. Students with learning disabilities also experience considerable difficulty identifying and correcting errors during the revision phase of writing (McNaughton, Hughes & Ofiesh, 1997).

Problems with poor spelling typically emerge early and persist as a serious deficiency through secondary school and through adulthood (Dalton, Winbury & Morocco, 1990). These difficulties hinder the ability of students to compose freely when writing. The focus for the student is on the difficult task of spelling at the expense of the development and expression of ideas. Poor spelling is a major impediment to writing effectiveness (Dalton, Winbury & Morocco, 1990). Many children who experience difficulties with handwriting and spelling are reluctant writers because

their writing has been criticized as being illegible and full of misspellings. Commonly, these children will develop strategies to cope with writing. These include restricting their vocabulary to simple words, avoiding complex sentence structure and writing very little (Outhred, 1987).

The National Dyslexic Association of the United Kingdom (1998) strongly supports the notion that those with writing, spelling and reading disabilities benefit from using computers. They claim that the use of such devices promotes independent written communication. The use of word processors helps to overcome handwriting and spelling problems and promotes self-esteem. Students with learning disabilities more easily remember letter patterns for words on the keyboard than for words written by hand because the print looks more like that found in books. Making use of a computer avoids the necessity of copying out work many times, making new mistakes each time. Word processors allow users to make changes to text that would be very cumbersome on paper (Bangert-Drowns,1993). These changes range from simple editing to the addition and subtraction of words and phrases to more complex and substantial reviews. Text becomes a fluid easily transformed means of communication that is closely associated with speech and with thinking. Users are better able to attend to higher order thinking processes when freed from simpler mechanical tasks. Having practised these skills, the writer is likely to transfer them to the pen and paper situation (Bangert-Drowns, 1993).

Word processing

The published research into the effectiveness of the word processor for students in the classroom can be divided into two categories. Research in the first of these two

categories de-emphasised the importance of classroom influences and context and of teaching strategies accompanying the word processing package. Often, these possibly confounding influences were not described and explored. Their influence on the outcome was overlooked and discounted. Research in the second category examined the use of word processing packages in conjunction with explicit writing programs. The relevant research literature indicated that using the word processor alone without specific instruction did not produce an overall improvement in the quality of students' writing (Cochran-Smith, 1991). Its usefulness is best evaluated in the context of the learning environment, its social components and the goals and strategies of the individual classroom teachers (Cochran-Smith, 1991).

Benefits to students appeared to be most pronounced if an interactive program of instruction were introduced alongside the use of the word processor (Cochran-Smith, 1991). However published studies of the use of the word processor by students with learning disabilities did not compare the effects of the use of the word processor alone with the effects of using a word processing program together with an interactive instructive program. As both the word processor and an interactive program were introduced together, the effects of either intervention on the writing of students with learning disabilities could not be determined.

Aim and methodology

The aim of the present study was to compare the effect on writing of the use of the word processor in conjunction with the provision of an interactive program with the effect of the use of a word processor alone. Interactive teaching programs were introduced to students with learning disabilities who used the word processor to write.

An interactive teaching program features a two-way exchange of ideas and information between teacher and student. The effects on the writing of the participants were compared to those achieved when the word processor was used without the provision of the interactive programs. The two interactive teaching programs provided across the course of the program were a vocabulary-based instructional program and a feedback-based instructional program.

The chosen treatment method in the present study was a multiphase single subject design. While a group based research design is a quantitative study that makes comparisons between groups of students, the single subject research design focuses on a single individual (Alberto & Troutman, 1995). Comparisons are made between the participant's performance under an experimental condition and his or her past performance under a different condition. This initial condition is called the baseline (Wolery, Bailey & Sugai, 1988). Comparisons are not made between the participant and other students. One advantage of the single subject design is that often in group-based designs, data is averaged to give an overall estimate of group performance. This averaging process may obscure information about the variability of the results obtained for individual participants in a study. When a single subject research design is the method of choice for a study, additional information about individual performance including data of an anecdotal nature may be available for analysis (Alberto & Troutman, 1995). A disadvantage of the single subject research design is that, while inferences may be made to explain the behaviour of the individual, they cannot be made to a defined population. The findings of the study are particular to the participant (Alberto & Troutman, 1995).

Three Year 9 students with learning disabilities participated in the study across the course of five weeks. In keeping with the philosophy of a single subject research design, the results of the study were treated separately for each of the three participants. No comparisons were drawn between the three participants and information about each student was considered to be relevant to only that student. Across the course of the program, the three participants used the word processor to write science fiction stories of their own choosing. There were four phases across the program. The first phase was the baseline. The students used a word processor to write. No interactive teaching program was provided. In the second phase, the vocabulary-based interactive program was provided alongside the use of the word processor. The third phase of the program was a return-to-baseline. A return-to-baseline phase of a study is a phase with similar conditions to those present in the baseline (Wolery, Bailey & Sugai, 1988). In the final phase of the program, the feedback-based program was provided in conjunction with the use of the word processor.

The second chapter of this report includes a discussion of the relevant research literature. This literature forms the basis of the rationale for the present study. In the third chapter of the report, the hypothesis for the study is stated in its complete form, the independent and dependent variables are formally defined and the details of the study are delineated.

Chapter Two

Literature Review

This chapter of the report reviews the published research on the effectiveness of word processing programs that aim to improve the writing of students with learning disabilities. Attention is then focussed on studies where an interactive teaching program was provided to students alongside the use of a word processor. A criticism of the studies reviewed in this latter group is that the word processor and the interactive teaching program were introduced to writing programs together. Improvements in writing could be attributed to the provision of the interactive program, to the use of a word processor, or to a combination of both factors.

The published research into the effectiveness of the word processor for students in the classroom can be divided into two categories. Some of the studies de-emphasised the importance of classroom influences and context and of teaching strategies accompanying the word processing package. Often, these possibly confounding influences were not described and explored. Their influence on outcomes was overlooked and discounted. Other research examined the use of word processing packages in conjunction with explicit writing programs. The following studies were in the first category, the relevance of classroom experiences being de-emphasised. During the course of the study, students were not provided with a specified teaching strategy alongside the use of the word processor. Classroom influences were considered to be relatively unimportant.

Research that de-emphasises classroom influences

Outhred (1987) examined the effect of using a word processor on the writing of children with learning difficulties. The participants in this study were fifteen children aged from 8years and 6 months to 12 years and 0 months who were enrolled at the Macquarie University Special Education Centre. The children all performed poorly in one or more of the basic skill areas. The children were not separated into an experimental and a control group, the study being a pilot one. There were up to ten children in the class at any time with children staying in the program from 11 to 29 weeks. The children wrote two stories each week, one handwritten and one using a word processor. The stories produced were analyzed to assess differences in fluency and misspellings. Fluency has been found to be strongly associated with the quality of children's written work. It also seems to differentiate low and high ability students. In general, children with learning disabilities wrote one third to one half as much as did non-handicapped peers (Outhred, 1987). Misspellings were included in the author's assessment of writing because the author claimed that children make less spelling errors when they type. He also considered that the use of the word processor reduced the frequency of letter reversals.

The length of stories that the children produced increased with time (Outhred, 1987). The children were not taught to type so probably became more proficient with the keyboard as the study progressed. They also became more practised as writers. The effects of using a word processor were related to the specific problems that the children were experiencing in their written work. The children with severe spelling problems made fewer errors in their word-processed stories while the reluctant writers tended to write more. Typed stories contained fewer spelling errors than did

handwritten stories. This difference was most pronounced for those children with average to above average ability who had learning disabilities. Two students who tended to use visual cues when trying to remember how to spell a word made the greatest gains. A limitation of the study was that the children were restricted to 30 minute sessions at the word processor (Outhred, 1987).

The results of the study by Outhred (1987) were encouraging. Students who were poor writers improved their stories quite markedly. The study suggested that children make less spelling errors when using the word processor and that they enjoy using it for writing stories, the gains being most pronounced for learning disabled students of average to above average ability. While lack of typing skills seemed to limit fluency, the students were willing to continue with their stories for longer when they used the word processor. Spelling errors were also reduced in this condition and students were more willing to share their work (Outhred, 1987).

Many students who experience developmental writing disorders have difficulty in subject areas that demand a substantial amount of writing (Hoy, 1993). Hoy (1993) examined the comparative effects of two classroom formats, one traditional, the other providing a word processor and basic instruction in its use. Hoy (1993) employed a quasi-experimental study that compared the grade equivalents of students with learning disabilities in English composition classes using the two formats. The students attended San Antonio College, a college with an open door admission policy which allowed student entry based on college entrance examination scores. Students with learning disabilities have often done well on these tests which do not contain an

essay component, but they encounter difficulty on the assignments when they attend college.

The students partaking in Hoy's study were identified through the Disabled Student Service Office (Hoy, 1993). They were all identified as learning disabled according to USA federal guidelines, their standard scores on achievement tests being one or more standard deviations below their standard scores on an intelligence test. All subjects scored within the normal range of intelligence. One group of 25 students was instructed in the use of the word processor and used a word processing format. The students in the word processing class received instruction regarding its use. The other group of 25 students used traditional formats. The grades achieved by the students prior to the study were analyzed. The success of the program was evaluated based on the final grade awarded to the students undertaking the course.

Hoy (1993) found that the word processing format did not offer a clear advantage over the traditional format in terms of academic progress. A contrast between the groups revealed no significant difference between the two groups. The experiment was not well controlled in terms of the presentation of the methodology and allowing for differences in the personality of the instructors in the classes. In spite of the negative results, many students using the word processing format achieved a passing grade. Therefore the word processor may be a good option for students with poor handwriting or for those who express a preference for using this format. Additionally, the word processing format may prove a motivating instrument for some students.

Dalton and Watson (1986) studied the effectiveness of the word processor for students of different achievement levels. The participants were 80 remedial seventh grade students. These students were divided into two groups on the basis of higher or lower achievement based on a writing pretest. Half of the students completed assignments in the traditional manner while the other half used a word processor. The low achieving students in the word processing group made substantial gains. The high achieving students were frustrated over their lack of keyboard skills. The word processing students failed to plan before composing their assignments.

Morocco and Neuman (1986) conducted case studies to determine how using a word processor affected the writing skills of students working in their regular classroom settings. A group of fourteen fourth graders with learning disabilities participated in the study. The study was undertaken over an eight-month period and involved five remedial teachers and their students. Students were observed and assessed while producing written work both by hand and by means of the computer. Positive findings suggested that the word processing condition made the writing experience an easier one to share, allowing opportunities for collaboration and giving the teacher easy access to student work. The students took more risks when they began to write and easily rearranged their text. Negative effects of using the word processor included the students being distracted by the ease of editing and revising too early, and the teacher focusing too early on formatting and mechanics rather than on content.

Morocco and Newman (1986) conducted a second study to determine the effects of using a word processor on the writing of students with learning disabilities. The participants were eleven fifth and sixth grade students with learning disabilities. As a

result of word processing, the students were more willing to experiment as they began to write. The students revised their work more than did students using pen and paper. They also collaborated with other students in producing their stories.

To determine the comparative effectiveness of using a word processor, MacArthur and Graham (1987) provided three different classroom formats to groups of fifth and sixth grade students with learning disabilities. These students were already familiar with word processing. Once a week for three weeks the students created and revised stories under three conditions. These conditions were dictation when the students spoke their stories into a tape recorder, handwriting and word processing. The study compared composition length, thought units, vocabulary, number of more mature words, grammatical errors and composing time. The results showed that the dictation condition produced the longest stories. Word processing and handwriting produced similar results but the word processing efforts took two to three times longer to produce.

A long-term study of the effects of using a word processor was conducted by Collis (cited in Majsterek, 1990). The participants were 126 students who were severely learning disabled and whose ages ranged from six to fourteen years. These students were initially taught to use the word processor. Three pairs of writing samples were collected over six months, each consisting of a first draft and a handwritten story. Comparisons were made on a number of factors, including grammar, syntax, production, length, spelling and neatness. Results indicated very few differences between the samples except for more correct spelling, greater fluency (number of words) and neater products with the word processor.

Posey (cited by Liechty, 1989) studied a group of college students who chose whether or not to use the word processor for a basic English course. Thirteen students voluntarily divided into two groups, some opting to use word processors and some opting to complete work by hand. Pretests and posttests were conducted, students kept journals, were interviewed, and written work was assessed. Few differences were observed between the two groups, although the computer users wrote more. The students in the word processing group made many revisions and believed that they had put more effort into their writing. Analysis however revealed little substantive revision in either group.

MacArthur and Graham (1987) examined the effects of providing word processing facilities without an instructional strategy. They found no significant differences in the number or type of revisions that students with learning disabilities made using pen and paper as opposed to using the word processor when no instruction strategy was provided to the students. The final drafts did not differ in any of the measures including overall quality, length, story structure, vocabulary, syntactic complexity, spelling, capitalization and punctuation.

A study conducted by Philips (1995) determined the long-term effects of the use of a word processor on writing over an eighteen-month period. The study assessed the impact of word processors on the writing of nine children aged from nine years to eleven years who attended a school on the South Island of New Zealand. Three of the children were competent writers, three were average and three writers were experiencing difficulties. During this eighteen-month period, the students wrote with

both pen and paper and by using the word processor. A wide range of data was collected on each pupil. This included test scores, questionnaire answers, diary comments, writing samples and notes based on formal observations. Teaching strategies varied under different combinations of time, classroom management strategies, and teacher input during different stages of the study.

The results of Philip's study (1995) indicated that students were strongly motivated to write when using the word processor. They produced greater quantities of written work using this mechanism. The number of ideas and the variety of sentence structure also improved. The children enjoyed sharing their writing with each other. Philip's long term study (1995) showed that most of the students demonstrated improved writing skills when using the word processor. Both students and teachers enjoyed using the word processor. The children who were reluctant writers increased their writing output, although the quality of the writing did not appear to improve. The use of the word processor was an important contributor to the development of the students' writing skills. Possible confounding factors included natural maturational effects, teacher personality and changes in classroom teachers. In addition, progress was inconsistent and there was considerable variability in individual learning rates. The results indicated that the use of spelling checkers had not resulted in an improvement in spelling.

Lichtenstien (1996) studied the effects of the use of word processing on the quality of children's writing. The participants for this study were 32 fifth grade students in a New Jersey public school. One group of sixteen students from one classroom was the experimental group. They made use of computers in the classroom to produce their

written work. The second group of sixteen students used computers once a week in a computer laboratory. On a daily basis, they used pen and paper to produce their written work. This classroom regime continued for five months. Writing samples were taken as pretests and posttests. These samples were scored holistically. No significant differences were observed between the two groups of students. However, the differences in mean scores did approach significance. There was an implication that if the study had continued longer, the experimental group would have made significant gains over the control group.

A study by Haas (1988) determined the effects of the use of the word processor on how students plan their writing. Ten experienced writers and ten student writers each composed three essays, one by means of the word processor, one by means of pen and paper, and one by means of a combination of both. No significant differences were observed in composing rates, although the essays written on computer were longer. Both groups planned most in the pen and paper condition and least in the word processing condition. Planning was more sequential and less conceptual when the subjects used the word processor.

Pearson and Wilkinson (1986) examined the effects of using a word processor on writing revision. Fifteen young adolescents of mixed abilities were the participants in this study. These students were experienced in using word processors. The word processor facilitated their revision efforts, particularly if the student were willing to make changes in handwritten copies. The researchers established that the revision undertaken was of a more thorough nature than the surface tinkering often ascribed to students revising while using a word processor. Collier (1983) hypothesized that use

of the word processor would significantly improve the revising skills of inexperienced writers. Four female students of varying abilities and with no computer experience were selected for this study. No significant improvement in skills was found. Word processing did encourage more surface changes, and experimentation with text, and the length of stories increased slightly. While high-ability level students benefited most, pen and paper revisions were more substantial and successful for those with the weakest writing skills. Weaknesses of this study were the small number of subjects and the lack of a control group.

Broderick and Trushew (cited by Cochran-Smith, 1991) investigated the development of revision skills by students using the word processor over an eight-week period. The fourth grade participants initially used the word processor to produce flawless texts. As time went on the children learnt to delay the revision stage until the end of the process. They began to use more sophisticated revision and revising strategies. Levin (cited by Leichty, 1989) studied the effects of word processing on the number of spelling errors that students successfully corrected. Twenty-nine sixth graders each wrote and edited two stories, one by hand and the other using a word processor. Students corrected 78% of the errors on the computer papers and only 44% of those on the rewritten papers. Ninety per cent of the students actually made new errors on their written stories during this revision phase. Only 30% of the students made new errors on their computer papers. The final drafts of the handwritten papers contained significantly more errors than the word-processed papers.

The use of spelling checkers

Most word processors include a spelling checker. The two most serious limitations of spelling checkers are that they fail to flag errors that are in fact other words spelled correctly and that they identify as errors some words that are correctly spelled, such as names. Thirty per cent of students' spelling errors are other real words. The word processor changes the task of correcting spellings from one of recall to the easier task of recognition. In order to present the correct spelling, the word processor may present a range of possible choices in a list. Although recognizing a word is easier than recalling one, this may still be confusing for a student with a learning disability. When the error is more severe, the correct alternative is less likely to be presented. Therefore a poor speller may experience more problems correcting work than a good speller (MacArthur, Graham, Haynes & DeLaPaz, 1996).

Dalton, Winbury and Morocco (1990) explored the use of spelling checkers in other contexts. They reported case studies of two fourth-grade students with learning disabilities with serious spelling problems. Both students increased their spelling accuracy with the support of a spelling checker. However, the student who made more errors corrected a smaller percentage of those errors. Thus the spelling checker suggested the correct word more often for the student who made fewer and less severe errors. The students almost always fixed the error if the spelling checker made the correct suggestion, and almost never fixed the error if the spelling checker did not do so. This implies that spelling checkers may be less effective for those writers who have the most serious problems in spelling.

Dalton, Winbury and Morocco (1990) evaluated the effect of training in the use of editing strategies in conjunction with use of the computer spelling checker. The researchers devised a program that taught boys with a learning disability to use a spelling checker. They then assessed how skillfully they could correct their own spelling during the editing stage of writing. The participants for this study were the same two fourth grade boys with spelling problems who took part in the previous experiment. The students were chosen for the study because they both had serious spelling problems. They were taught to use a word processing and spelling checker program to edit spelling errors. When they had mastered the use of the spelling checker, the students worked collaboratively with a peer who was a more able speller. The training process started with the participants working on graded exercises and continued with the more difficult task of editing their own work.

The students in the study conducted by Dalton, Winbury and Morocco (1990) learned to manage the spelling checker, increased the spelling accuracy of their edited texts and reported that they enjoyed using the spelling checker. The success rate was improved further still when additional resources were provided, these being a spelling handbook and the peer assistance. Limitations in the current technology influenced their editing efficiency. Neither boy identified spelling errors that the checker missed. Both boys relied on the assistance of a peer to help generate alternative spellings when the correct word was not presented. Both students perceived the checker to be a very useful tool and felt comfortable using it. Dalton, Winbury and Morocco (1990) claim that all learning disabled students will need to learn strategies to use the word processor spelling checker effectively. Peer collaboration where the peer is a more

able speller will also make a difference. A weakness of the study is that it included data on only two subjects.

MacArthur, Graham, Haynes and DeLa Paz (1996) conducted two studies to investigate the benefits and limitations of spelling checkers for students with learning disabilities. The first study compared the performance of ten widely used spelling checkers. The spelling checkers suggested correct spellings for words generated from the misspellings of 55 grade five through eight students with learning disabilities. The results of the study indicated that the spelling checkers most commonly used in the classroom performed well enough to be helpful to students with spelling problems, but not well enough to be used without some frustration on the part of the student. The spelling checkers failed to identify some spelling errors and flagged names that were correct. Sometimes quite long lists of choices were generated with the correct response not always at the top of the list. Sometimes the correct choice was not presented. The spelling checkers failed to flag some errors because they were real words. The correct spelling was only suggested in the list of words generated about half of the time. The spelling checkers showed considerable variability in performance.

The second study conducted by MacArthur, Graham, Haynes and DeLaPaz (1996) investigated the relative successes achieved by students with learning disabilities when they corrected their spelling errors with and without a spelling checker. The participants were twenty-seven students with learning disabilities from grade six through grade eight. When using the spelling checker, the students corrected 37 percent of their errors. Spelling checkers failed to identify 37 percent of errors,

because they could be deemed to be correct in other contexts. Spelling checkers suggested one form of the correct spelling 55 percent of the time. When a possible correct spelling was suggested, students usually chose it.

Possible negative consequences of the use of word processors

Some researchers have raised concerns about possible negative consequences of the use of the word processor. Bangert-Drowns (1993) suggests that unless the word processor is used in conjunction with a learning program, there may be no explicit improvements in writing performance. Use of a spelling checker may remove the responsibility for spelling from the writer, so that the writer is slower to master these tasks (Cochran-Smith, 1991). The use of the word processor could have negative effects on writing, especially on student revisions. Young writers are continuously learning and developing writing strategies. They may not be able to simultaneously manage the technological operations of word processing (Cochran-Smith, 1991). Less confident students could experience anxiety about producing text on a screen where it is easily visible to other students. The use of spelling and grammar checkers could result in dependence on the electronic format in lieu of the development of self-correction strategies. The final product could look better without actual improvements in writing skills (Majsterek, 1990). People who have learnt to write by hand need to expend energy mastering key boarding skills (Liechty, 1989).

The use of word processors in conjunction with explicit writing programs

Several studies have investigated the effectiveness of word processing packages in conjunction with explicit writing programs and their effects on the writing process. Cochran-Smith (1991) claims that the effectiveness of word processing cannot be

determined apart from the context of the instructional setting and the social system of the classroom. He has criticised much of the research conducted on the use of the word processor, claiming that the classroom context and educational strategies implemented are often ignored and are regarded as inconsequential to the effectiveness of the word processor.

A study by Yau (1991) emphasized the role of teachers as facilitators of the process of writing. This aspect of the problem is particularly important, if the full potential of the word processor is to be realized. The study examined the impact of word processing on the way students approach the writing task. Nine elementary teachers were trained in how to make naturalistic observations. The teachers observed their students' word processing behaviour over a period of six months. The teachers recorded their observations on log sheets and they provided more detailed descriptions in journal forms. Three conventional writing stages, planning, composing and editing and revising were used as a framework for analysis. Results indicated that the teacher should take an active role in the writing process if improvements in writing are to be maximized. Teachers need to be supported in this role. The word processor is used most effectively when it is introduced alongside explicit instructional strategies (Yau, 1991).

Bangert-Drowns (1993) has claimed that unless the word processor is used in conjunction with a learning program, there may be no explicit improvements in writing performance. Use of a spelling checker may remove the responsibility for spelling from the writer so that the writer is slower to master these tasks. The use of the word processor could have negative effects on writing processes, especially in

terms of student revision. Young writers are in the process of learning and developing writing strategies. They may not be able to manage simultaneously the technological operations of word processing (Cochran-Smith, 1991).

In a study of first and second grade classrooms, Dickinson (cited by Cochran-Smith, 1991) examined the effect of the combination of a collaborative style of instruction with the use of the word processor. He established that collaboration is encouraged when students make use of word processing. The teacher, after initial reticence, allowed and encouraged collaborative writing at the computer. This arrangement resulted in more talk about planning, writing and responding than did the less frequent collaboration that occurred with pen and paper productions. Stoddard and MacArthur (cited by Macarthur, 1996) provided instruction in a peer-revision strategy in which pairs of students with learning disabilities learned to help each other. This strategy instruction, in combination with the word processor, resulted in substantive revisions and improvement in the overall quality of compositions.

McNaughton, Hughes and Ofiesh (1997) conducted a study to investigate the impact of integrated proofreading strategy training on the writing of students with a learning disability. The use of a computer-based spelling checker was combined with the teaching of student proofreading strategies. Students with a learning disability were deficient in the use of effective strategies for the completion of the task of proofreading (McNaughton, Hughes & Ofiesh, 1997). Three high school students with learning disabilities were taught to apply a multi-step proofreading strategy with controlled material in a variety of activities. The strategy used was the error-monitoring strategy, a five-step plan. The students were aged between 15 and 18

years. All were experienced with the word processing software. A multiple-probe across participants design was used with three phases: baseline, intervention and maintenance phase. The independent variable was the instruction in the proofreading strategy.

The results of the study by McNaughton, Hughes and Ofiesh (1997) indicated that high school students could be taught an integrated approach to proofreading that enabled them to detect and correct errors independent of teacher assistance. When provided with such strategies, the students used them effectively. They produced fewer spelling errors and had a final spelling error rate that fell within the performance range of non-disabled peers. The study suggests that access to technology alone will not enable students with learning disabilities to perform at levels comparable with normally performing peers. This strategy instruction, in combination with the word processor, resulted in substantive revisions and improvement in overall quality of the compositions. Some weaknesses of this study include the fact that the participants were not randomly selected from the population of students with learning disabilities and that the sample size was very small. The study was restricted to only some aspects of editing and revising, in particular the detection and correction of spelling errors. Further direction may be required by students with learning disabilities if they are to undertake effective revisions of a more substantial nature.

MacArthur, Graham, Schwartz and Schafer (1995) evaluated the effectiveness of a multidimensional instruction program. The model included word processing, explicit strategy instruction and a process approach. The students worked in a meaningful

social context, sharing writing with peers and publishing for an audience. There were extended cycles of planning, drafting and revising. The experimental model was implemented for one full school year. The experimental group comprised of 12 classes with 113 students with learning disabilities. These students made greater gains in the quality of their writing than did students with learning disabilities in ten control classes.

Storeygard, Simmons, Stumpf and Pavloglou (1993) conducted a writing program that comprised explicit instruction, peer reviewing, collaboration and conferencing. The computers and writers course combined these strategies with word processing. The course aimed to meet the needs of reluctant writers. The students who partook of the course were blocked writers who had trouble generating ideas as well as difficulties such as illegible writing and poor spelling. Initially, teachers stressed skill acquisition with an emphasis on keyboarding and spelling. They then progressed to more complex skills, taking into account the needs of each student. Students developed very positive attitudes both to their writing and the computer. The students, with teacher assistance, learnt to draft and to refine their work. Writing skills improved significantly from pretest to posttest.

Kerchner and Kistinger (1984) conducted a study that determined the effectiveness of a process learning strategy combined with a word processing program. The process learning strategy emphasized writing as an active process. Key features of a process approach are writing for a purpose and a gradual evolution of the final product through revision, discussion and collaboration (Kerchner & Kistinger, 1984). The participants, students in fourth, fifth and sixth grade who experienced difficulties with

learning, were placed into two groups. The experimental group was taught a process approach to writing and made use of a word processor. The children in the control group used pen and paper. This second group was taught the writing process by an extensive language experience method. The study was conducted across one school year. Progress was determined through the administration of standardized tests in language production. The word processing group showed significantly more progress in the quality of the final product. It was impossible to determine, however, whether improvement was due to the word processing itself, to the process approach to writing, or to a combination of the two factors.

In Kurth and Stromberg's study (1984) two groups of nine middle-school remedial students were given a process approach to written composition. One group used word processing while the other did not. The word processing group produced as many compositions as did the other group, even though they had had to learn to use the word processor with appropriate key boarding skills. The students using the word processor were more motivated, produced more rough drafts, and did more group editing.

In a study conducted by Dalton, Winbury and Morocco (1990) students were provided with an explicit teaching program. The teaching program involved having the participants work through exercises that incrementally developed their editing skills. Peer collaboration involving peers who are more able spellers was also a valuable resource. The authors claimed that students with a learning disability experience difficulties when using a spelling checker as a component of a word processing package. These students often have weak word recognition skills or are impulsive.

This leads to difficulties discriminating and selecting the correct response from a list of words. They find it difficult to reject false identifications of spelling words by the computer. When the spelling checker does not suggest the correct spelling, students may find difficulty generating their own alternative spellings. Because editing is difficult for them, these students rely heavily on the spelling checker to make all the decisions for them, thus not identifying homonym confusions.

Dalton, Winbury and Morocco (1990) concluded that students with learning disabilities need additional editing support to correct errors either missed or not corrected by the spelling checker. If students with learning disabilities were taught editing strategies, they used the word processor spelling checker effectively.

Levine, Conitsa-Schmidt and Zellermayer (1996) addressed the issue of the influence of classroom climate on competencies in word processing. The study involved the teaching of writing composition skills within a process-orientated, computer-supported rich-communicative environment. The rich-communicative environment has several key features. Student writing must be relevant to the lives and interests of the students. Students should be given time to plan and to revise their writing. There should be opportunities for peer collaboration and for teacher-student interactions. The students should have access to a word processing program. Finally, students should be given self-evaluation prompts and strategy sheets (Levine, Conitsa-Schmidt & Zellermayer, 1996). Two high schools employed different instructional strategies in their writing classes and the differing effects of the classroom environments were employed in the study. The experimental school implemented a communicative instructional approach to writing within a technological environment where the

students made use of the word processor for writing. The second school served as a control group and used a traditional strategy for instruction in writing and traditional pen and paper for the writing process itself. The sample included 951 year ten and eleven students (Levine, Conitsa-Schmidt & Zellermayer, 1996).

Levine, Conitsa-Schmidt & Zellermayer (1996) studied six dimensions of the classroom environment. These were teacher-student relations, peer relations, writing processes, the role of the computer as a word processor, classroom management and student responsibility. Student perceptions of the classroom environment served as the assessment tool for this study. The results showed that for each of these dimensions, the students in the experimental group perceived their classroom environment in a more positive light than did the students in the control group. Boys perceived the classroom climate differently from girls and perceived the computer in a more positive light than did the girls in the study. However, girls in the communicative environment regarded the use of the word processor as highly as did the boys in the control group. In the experimental group, no differences were found between students with prior computer experience and those who were inexperienced. However, differences were found in the attitudes of students in the traditional classroom. It appears that students in the communicative classrooms recognized the value of integrating a word processor into the learning of writing, even if they had no prior experience with the use of one.

The study by Levine, Conitsa-Schmidt and Zellermayer (1996) indicated that all aspects of the instructional environment influenced the effectiveness of a word processing package. The study suggests that a holistic approach is important in some

contexts. Neither the introduction of computers alone, nor changes in the nature of the learning and assessment processes of writing alone are likely to create an environment that fosters communication and reflection in students' working with computers. However, the effects of the use of the word processor or the communicative instructional approach to writing were not established.

Criticisms of current studies

It is appropriate to highlight weaknesses in some of the studies on the use of word processors in improving the writing skills of students with learning disabilities. Some of the research designs contained flaws or the studies were inadequately controlled. First, many of the studies were conducted over a relatively short term. These underestimate the power of the word processing process, because most students show improvements over extended periods of time as they master keyboarding skills. When using the computer, inexperienced writers tend to make a number of typing errors. Therefore, the increased number of revisions performed may be an artifact resulting from an increased number of errors in the early drafts. On the other hand, revisions may be underestimated. Because the boundaries between different stages of the process of writing tend to blur in word processing, a number of revisions may be made during earlier drafts, even during the production of the initial draft. This complication needs to be taken into consideration in making judgment about treatment effects.

An important criticism of several studies is that they did not report on factors within the classroom that may have had a direct or indirect effect on writing strategies. There was an assumption that word processing operated in a void that would not be

influenced by these factors (Cochran-Smith, 1991). Many of the findings from research are ambiguous, with the findings of some individual studies being contradictory. It appears that unspecified contextual features may affect the potential impact of word processing on writing. The nature of the context of the studies was often not explained (Bangert-Drowns, 1993).

Several of the group-based studies included a very small number of participants. For example, there were only four students in the study conducted by Collier (cited by Liechty, 1989). In other studies the participants did not represent a typical sample of the broader school population. For example, in the study by Dalton, Winbury and Morocco (1990), two students were chosen because they had characteristics that represented more extreme ends of the learning disability continuum. These research findings may not be generalisable to the broader population of students with learning disabilities. In certain of the other studies, there were differences between the control and the test populations. For example, in the studies by Hoy (1993) and Posey (cited by Liechty, 1989), the participants chose the group to which they wished to be assigned. Those who chose the word processing group may have had different attitudes and experiences to those who chose to use pen and paper.

Several of the research reports did not include a control group. For example, the study conducted by Outhred (1987) focused only on the target group performance. In these cases all of the students undertook the program with the word processor. Changes that occurred for these students may have been the result of maturational effects, particularly as some of the studies were conducted over several months. Studies by Kerchner and Kistinger (1984), MacArthur, Graham, Schwartz and Schafer (1995)

and Storeygard, Simmons, Stumpf and Pavloglou (1993) introduced word processing in conjunction with an educational strategy that was not presented to the control group. In these cases, it is impossible to attribute changes in writing behaviour to the word processor, to the particular strategy or to a combination of the two.

Conclusions drawn from the relevant research literature

The composite body of research highlights many positive features that the word processor brings to the writing situation. MacArthur (1996) stated that word processors give the student the ability to produce neat printed work and the opportunity to correct work without obvious erasures. Student work is easily published in a wide range of professional-looking formats. The visibility of the text on the screen facilitates collaboration with other students and encourages step-by-step interactions between teacher and student. The teacher has more ready access to each student's writing processes. The teacher can model writing processes using a large monitor or a projection panel discussing strategies for planning and revision. When students use a word processor to write, the quality and quantity of their written products are affected. Once they have mastered the keyboard, many students produce a longer text. They spend more time writing. The work produced is perceived by the students to be neater and it typically contains fewer errors than do handwritten products. Students enjoy using the word processor and have positive attitudes towards their work in this mode (Cochran-Smith, 1991).

When students with learning disabilities made use of the word processor, there were considerable increases in fluency (Cochran-Smith, 1991). Writers using the word processor also spent more time writing than did those using pen and paper. Most

students found working at the computer to be enjoyable. Writers with limited skills increased the time they worked on assignments, whether or not additional instruction was provided. They produced longer compositions and assignments. Several studies have indicated that basic-skill writers were more inclined to read what they had written when the word processor was used. They more easily recognized and corrected their errors on the word processor. Over time, word processing helped children who had been preoccupied with print production to shift the focus of their attention to higher-order tasks. They came to understand that writing is a process that centered on the nature of the information to be imparted and the impact on the audience (Cochran-Smith, 1991).

Cochran-Smith (1991) suggested that students have a preference for word processing because they feel in control of the technology, enjoy the computer being the first audience for their work, and are impressed by the professional looking results that they achieve. Bangert-Drowns (1993) determined that the use of the word processor results in an improvement in the quality of writing, particularly for weaker writers. They also produced longer documents than when they used pen and paper. These documents were relatively free of basic spelling and grammatical errors. Word processing students generally have more positive attitudes towards writing than students who write their stories by hand.

Bangert-Drowns (1993) claimed that students with basic writing skills appear to benefit the most from word processing. Several studies have indicated that the word processor changes the nature of student planning and the revision of the products of writing. The first steps in writing, planning or generating material for writing occurred

less frequently when writing was done at the word processor. Revision tended to be of a more superficial nature. Most changes involved spelling or punctuation corrections (Liechty, 1989). The computer encouraged surface level changes, by making minimal changes easy, but substantial changes more difficult. Most studies showed that although a student may make more revisions when using a word processor, few of the changes made were substantive. Some studies indicated that word processing had a negative effect on student revision, with more effective revisions being conducted when pen and paper were used (Liechty, 1989). Students were found to revise differently when they used the word processor. They revised during the composing stage and not just at the completion of the task (Liechty, 1989).

When students write using the word processor, they usually make a greater number of revisions than they would when using pen and paper. However these revisions tend to be of a superficial nature (Cochran-Smith, 1991). The failure to make large scale revisions could reflect the fact that less able students are not able to manipulate the more advanced editing functions such as cutting and pasting (Yau, 1991). When students use the word processor, they often increase the total number of changes made to their work. However, they do not undertake revisions that improve the overall quality of their writing, unless there is a specific instructional intervention (Cochran-Smith, 1991).

The body of research regarding the use of the word processor by students with learning difficulties presents conflicting results regarding the ease with which these students master the keyboard. While many researchers suggested that students quickly master the keyboard and that it presents no particular barrier to student participation

in the writing process, some researchers caution that keyboarding skills needed to be explicitly taught and that time should be set aside to establish keyboard mastery. Cochran-Smith (1991) claimed that children of all ability levels could learn to use a keyboard. Inexperienced writers learn commands fairly easily, have only minor keyboarding problems and are unintimidated by the computer itself. Smith (1991) stated that using a keyboard does in fact result in a temporary loss of writing fluency while keyboarding skills are learned. During this early stage, children focus on mastering the keyboard and other word processing skills rather than on the content of their writing. Smith (1991) claimed that children with learning disabilities need to develop both word processing and keyboarding skills through regular practice sessions and that keyboard competency should not be simply assumed.

MacArthur (1996) stated that competencies in typing are not a part of standard curricula. Therefore, some typing instruction is important if the best effects are to be achieved. Majsterek (1990) pointed out that perceptual-motor or coordination difficulties might be a greater consideration for students with learning disabilities than for other students. However, recommendations about when students should start to learn keyboarding skills are based more on opinion than research. Majsterek (1990) stated that keyboarding skills would best be taught prior to the commencement of a writing program.

Research indicates that using the word processor alone, without specific instruction in its use, does not produce an overall improvement in the quality of students' writing (Cochran-Smith, 1991). Its usefulness should be evaluated in the context of the learning environment, its social components, and the goals and strategies of the

individual classroom teachers (Cochran-Smith, 1991). Many children who experience learning disabilities can be successful if they receive enriched instruction. One method of effectively dealing with a learning disability is to develop specific pedagogical methods for writing instruction (da Foseca, 1996). The most critical differentiating factors appear to be the presence or absence of instruction and the nature of the learning context (Cochran-Smith, 1991).

Lichtenstien (1996) claimed that, while the computer can be used to make the writing process more efficient, it cannot take the role of teacher. Bangert-Drowns stated that the word processor is a cognitive tool. As such, it does not "educate" in the way that a tutorial does. Tutorials have specific educational objectives and provide guidance and practice to achieve these objectives.

When combined with an effective writing instruction program, word processing can yield considerable benefits for students with learning disabilities. Bahr, Nelson and Van Meter (1996) stated that word processors have the potential to motivate reluctant writers, to facilitate the physical processes of writing, revising and editing. The result is the publication of neatly printed work. However, the ambiguous results obtained in different studies highlights the fact that simply providing a student with a word processor as a tool will not necessarily confer any special benefits in terms of written language skill. An instructional approach that focuses on writing as a process accompanied by explicit instruction in the use of strategies for planning and peer revision shows promising results for students (Bahr, Nelson & Van Meter, 1996). The benefits of word processing may be weakened by an over-reliance on incidental learning and a lack of explicit emphasis on the mechanics of writing.

The beneficial effects of word processing are most pronounced in an instructional context that focuses on writing as a process. Students also do better if they are specifically taught how to improve their papers using revision strategies facilitated in a word processing environment. Spelling checkers alone improve greatly a paper's legibility and alter a teacher's perception of competence and intelligence. However, it is very important that effective strategies for using the checker are explicitly taught (Anderson-Inman, Knox-Quinn & Horney, 1996). The research of Lichtenstien (1996) suggested that the use of the word processor complements a process approach to writing. Where word processing was combined with such an approach, students with learning disabilities showed significant improvements in writing performance (Lichtenstien, 1996).

Cochran-Smith (1991) reported that it was usually effective to use word processors in combination with instructional activities that invite students to think about their own writing strategies and to view writing as an unfolding process. Most of these strategies included peer or teacher-student conferences or small group work. In each case, the strengths of the word processing mode were used to support the goals of the teacher. The teacher, in each case, aimed to improve writing by increasing the students' self-consciousness about their own composing strategies. There was an interactive relationship between the quality of instruction and the impact of word processing on students' writing.

Instructors working with students with learning disabilities provide effective writing programs if they explicitly teach writing strategies, provide opportunities to write, and

emphasize the communicative role of writing (Majsterek, 1990). MacArthur, Graham, Schwartz and Schafer (1995) favoured a comprehensive approach to writing instruction that incorporates a supportive classroom environment, meaningful writing tasks and explicit instruction alongside the use of the word processor. Teachers can also observe, coach, prompt and help students to clarify their ideas. Open and non-directive questions should be used in this guiding process. Yau (1991) outlined the many opportunities that teachers have to interact with and facilitate writing activities when an upright monitor and clear print are available.

Students benefit from the teacher's active involvement in the writing process. Yau's (1991) study suggested that, if the word processor is used alone with little input from teachers, its potential is unlikely to be realized. Some of its effects may in fact impede some aspects of text production. When students begin to take risks using the word processor, they tend to cut short the important phase of planning and organizing ideas. At the revision phase, high-level revisions are seldom undertaken. The teacher should provide instruction and guidance in writing strategies as well as word processing skills. Student progress should be continually monitored. Students should be reminded, for example, not to edit prematurely. The word processor should be used in conjunction with, rather than instead of, the word processor (Yau, 1991). When planning pen and paper may be a medium that better encourages jotting down, listing and charting preliminary ideas. When revising, pen and computer hard copy may allow more valuable revision. If the technology is used without a plan and with minimal teacher intervention, its capabilities are unlikely to be realized.

Instruction in revision in combination with word processing can significantly increase the amount and quality of revision activities completed by students with learning disabilities (MacArthur, 1996). Cochran-Smith (1991) claimed that when students use the word processor, they often increase the total number of changes made to their work. However, they do not undertake revisions that improve the overall quality of their writing, unless there is a specific instructional intervention. Liechty (1989) stated that students with learning disabilities benefit most of all from word processing if explicit instruction is given in revision skills. As these writers tend to cut short the planning process, writers would benefit from attention to this area. MacArthur (1986) stated that students do not spontaneously revise their writing. However, they are willing to revise when adult guidance is provided.

If teachers explicitly teach the keyboarding and word processing skills, students will generally show improvements in their writing (Yau, 1991). It is important to instruct such students directly in the operation of the spelling checker, beginning with practice exercises that build student knowledge incrementally. Students with learning disabilities find it difficult to transfer learning skills learnt in isolation to more general tasks, so this suggests that careful monitoring should occur throughout the whole process (Dalton, Winbury & Morocco, 1990). Peer collaboration provides another effective strategy for using the spelling checker. It supports the problem solving process when the word processor does not provide a correct solution. The joint collaboration encourages discussions about spelling conventions (Dalton, Winbury & Morocco, 1991).

The body of research suggests that the use of the word processor provides many benefits to the student with learning disabilities. There is evidence that both quality and quantity of writing are improved. Students enjoyed writing using a word processor. They were motivated to write longer stories than when they wrote using pen and paper.

The findings of some studies, however, indicated that the use of the word processor did not always result in improved writing skills. The planning stage of writing could be cut short when students used the word processor to write. Editing could be superficial in nature. These shortfalls can be overcome if an instruction program is implemented. Students with learning disabilities receive the greatest benefits from the word processor if they receive specific instructional in keyboarding. This is probably best provided before the commencement of the program. Instruction should also be provided in the use of spelling checkers and in effectively planning and revising work.

The word processor is used most effectively when it is considered in conjunction with explicit instruction in the use of efficient strategies. The word processor is a tool that does not provide instruction in writing. The most effective teaching strategies focus on writing as a process, accompanied by clear instruction in the use of strategies for planning and for revision. The use of a word processor naturally complements the process approach to writing. Peer collaboration is also a powerful and important tool in the writing process.

Several research studies on the use of the word processor to improve writing have flawed designs or are inadequately controlled. Some studies were of relatively short

duration. Several studies did not report on relevant factors within the classroom, such as the provision of strategy instruction and the various social interactions occurring within the classroom. Some studies included only a small sample of students. Subjects of some studies were not representative of the larger population of students with learning disabilities. Other studies did not include a control group. Improvements in performance could in these cases be attributed to maturational processes. Some studies introduced an instructional strategy in conjunction with the word processing program. It was impossible to ascertain the effects of either component acting alone.

A rationale for the current study

In this chapter, the results of a number of research studies indicated that a word processor served as an effective tool for improving students' writing when used in combination with a teaching program. A shortfall of the experimental method of studies introducing a teaching program is that the teaching program was introduced concurrently with the word processor. If the treatment design included a control group, the control group wrote using pen and paper rather than using a word processor. Improvements in writing could be attributed to the use of the word processor, the teaching program itself or a combination of the two. The present study offsets this problem of confounding variables.

In this multi-phase single subject study, students used a word processor to write. When a baseline was established, an interactive teaching program was introduced in conjunction with the use of the word processor. Comparisons were made between performance in writing when the interactive teaching program was provided and performance under baseline conditions. The participants in the study were three male

year nine students with learning disabilities. Two interactive teaching strategies were trialled in the study. The first of these was a vocabulary-based intervention. The second intervention was an feedback-based intervention. In Chapter Three of the report, the hypothesis for the present study is formally defined. The experimental method applied in conducting the study is outlined in detail.

Chapter Three

Methodology

The research methodology and design features employed in the study are outlined in this chapter. Relevant background details about the three participants in the study are provided. The hypothesis of the study is presented. The independent and dependent variables are defined.

Participants

The participants in the study were three students from Woodvale Senior High School. The students' English teachers selected them for the study. The selection criteria were those used by Healey (1996) in identifying students with learning disabilities. These criteria were discussed in Chapter One of the report. Specifically, the participants were all classified as underachievers, students who were perceived by their teachers to be writing at a level substantially below their ability level. Ability estimates were determined independently by the students' teachers. The participants were year nine male students. Year nine students were targeted because, due to constraints within the school, the needs of year nine students with learning difficulties were not addressed through existing remediation programs. Male students were chosen because the experimenter believed that the three boys would feel comfortable in working together. She also believed that boys would be likely to enjoy the science fiction theme of the program.

To preserve the anonymity of the three participants and to ensure the confidentiality of records pertaining to them, pseudonyms were assigned to each of the participants. Darren was identified in primary school as a student experiencing literacy problems.

His teacher reported that he experienced difficulties with writing. Prior to the commencement of the program he was assigned a D grade in English. His parents had expressed concern about his progress. He was a member of the lowest ability year nine English class. His classroom behaviour was better than that of most of the other students in this group. His teacher felt that with his positive attitude and willingness to apply himself, he might benefit from the program. The teacher also recognised that if this student were to improve his writing skills, he would need some special attention that was not available in his classroom.

Brian's teacher reported that his literacy skills were extremely poor. She claimed that he had little concept of sentence structure, spelling rules or paragraphing. The teacher stated that Brian's Year 8 results indicated he was very weak in English. He was identified in primary school as a reluctant writer. School records indicated that Brian had been diagnosed with attention deficit hyperactivity disorder. He regularly took medication to address this condition. His mother was very supportive of the school. Brian's teachers believed that he could not cope in a mainstream class and consequently he spent the first two or three weeks of year nine in the lowest ability English class. A number of the children in this class displayed very disruptive behaviour.

Brian demonstrated immature and outgoing behaviour in the classroom. As a consequence of his disruptive interactions with other class members, he was transferred to a regular class. While his teachers believed that he would struggle with the work, they hoped that this change would reduce discipline problems. Brian demonstrated excellent verbal skills showing considerable talent when performing

orally. He played a major role in the school production of the play Bugsy Malone. The student's teacher recognised his talent in this domain. She found him to have very good ideas that he could express orally, but not in written form. He suited the criteria for entry into the program, being a student who was recognised by his teacher to be performing below his perceived ability level.

Matthew's teacher reported that he had significant problems with literacy. He was not a fluent writer. He produced untidy, illegible writing. His spelling was very poor and his teacher believed that he deliberately made some letters unclear to hide uncertain spellings. He was identified in primary school as a reluctant writer. Matthew's teacher selected him for the program because she recognised that he had sound language comprehension skills and could verbally express interesting ideas. However, he was unable to commit these ideas to paper. He fitted the criteria for the program that was designed for year nine students who were identified as writing below their perceived ability level.

Prior to the commencement of the program Matthew was awarded a D grade level for English. He was a very poorly motivated student. He did not submit a number of assessments. His teacher reported that submitted work was untidy and of a very poor quality. This student experienced difficulties in his English class in Year 8. He clashed with the teacher and spent much of his time excluded from the class. As a result of these problems, he believed that many teachers held him in poor regard. The school had identified Matthew as an at risk student because of low self-esteem. He was placed in the Sports Challenge program, a program that is designed to raise students' self-esteem. Matthew's parents had just started a new business that was

consuming most of their time. His mother claimed that she was finding it difficult to spend any time with Matthew due to work pressures.

All three participants had some experience with the word processor and could type with minimal competency. They also understood many common computer commands. Brian's colleagues respected him as a computer expert.

Materials

The instructional program was conducted in a small computer classroom that contained several IBM compatible computers. Windows 98 and Word 7 were installed as software on the computers. A printer was available within the classroom. Other resources were printer paper, a set of 50 A3 sized black and white photocopied enlarged sketches taken from an anthology of science fiction stories (StMichael, 1983), a pin-up board, drawing pins, a white board and white board markers.

Word 7 is an IBM compatible word processing package. It features a spelling checker and a grammar checker. Spelling and grammar errors are initially identified on the screen. The writer easily accesses features providing extra spelling and grammar assistance.

Design

This study was a single subject research design. It consisted of four phases. The treatment phases followed the pattern ABAC. The first phase of the study, Phase A_1 was a baseline condition. In this phase, the word processor was used alone. This was followed in Phase B, by the introduction of a vocabulary-based intervention in

conjunction with the use of the word processor. The third phase of the study, Phase A_2 was a return-to-baseline condition. The final phase of the program, Phase C involved the introduction of an interactive feedback program in conjunction with the use of the word processor.

There were three participants in the study. This being a single subject research design, data on the dependent variables was collected for each of the three students over the course of the program under standard conditions. This allowed comparisons to be made between each participant's performance under different levels of the independent variable compared to performance under the initial baseline conditions. In keeping with the nature of single subject research design, no explicit comparisons were made between the three study participants.

Trial study

A trial study was conducted with two year nine boys as participants. The participants were of average ability. They did not have learning disabilities. The participants were members of a regular science class and their teachers selected them for this activity. The trial study was conducted in order to determine suitable parameters with respect to the timing of the program and to determine any logistical problems that could interfere with the smooth running of the intervention. The students worked in the computer laboratory. The experimenter asked the participants to write a story with a science fiction or space theme. The participants initially wrote continuously for five-minute periods. The students complained that this was too short a period of time so this was modified to a series of ten-minute writing sessions. This proved to be a more acceptable period of time from the perspective of the participants.

At the end of each writing session, the experimenter asked the students to stop writing and to print their work. The products were marked with an identifying number and date. The participants were then shown an A3 picture that was pinned onto the board and were asked to suggest ten words that related either to the picture or to their own stories. The words they suggested were written on a whiteboard placed next to the pin-up board. The participants then continued with another session of writing. This pattern was repeated across the remainder of the trial. The schedule was ten minutes' writing time, a printing phase, a brief positive comment about each story's developments, and then a brainstorm based on a new science fiction picture. Each picture was placed on the pin-up board. When a fourth picture was to be placed on the board, the first was removed so that there were only three pictures on display at any time.

An appropriate length of time of ten minutes for each writing cycle was established. Through the trial study, the scheduling of the lessons was examined and found to be realistic, practical and comfortable from the point of view of the students.

Selection of participants

The participants were invited to attend a program designed to help students improve the quality of their writing using a computer. This required their withdrawal from some English classes. The experimenter explained to the participants that their teachers had identified them as students who may benefit from the program. They were informed of their right to withdraw from the program at any time and they signed a consent form. The parents of the participants were contacted by telephone and the purpose of the study explained. The parents gave written consent for their

sons to participate in the program. The principal gave written consent for the study to be conducted as a component of the school's English program. The three participants all expressed willingness to attend. All were eager to participate in the study.

A class of 29 year nine students served as a comparison group. This group took part in the regular English program and did not access the computer during English lessons. While this group did not perform the function of a control group, their progress over the period of time covered by the study nevertheless provided points of comparison for each of the five dimensions of writing. The comparison group was a class of similar ability to the participants' English classes, the students being of middle and lower ability. The students in this group were tested at the beginning and at the completion of the program. On both occasions the class teacher told the class that a scientist friend of the experimenter wanted to find out what year nine students knew about space. They were told to write a story using pen and paper about any aspect of space or science fiction. There was a fifteen-minute time limit.

The program

The participants were withdrawn from their regular classes for two English lessons each week for a period of five weeks. Each of these sessions was seventy-five minutes in length. The sessions chosen were both morning sessions. At the start of the first lesson, the participants were given an identical test to that given to the students in the comparison group. They were told that a scientist friend of the experimenter was interested in finding out what year nine students knew about space. They were asked to spend fifteen minutes writing a story about any aspect of space or science fiction. When performing this task they were to use pen and paper.

The participants were then introduced to computer writing. They were told they were to write a story that could be used in a TV series about science fiction or space. They could write one very long story or a series of shorter stories.

Phase A_1 The participants in the study wrote their stories on the computer for several ten-minute periods. No interactive instruction was provided. At the completion of each ten-minute segment, the stories were printed and labeled with an identifying mark. The researcher made an encouraging comment about each story's developments and the participants then continued with another ten-minute segment of writing. Phase A_1 was the baseline condition.

Phase B During phase B an interactive instructional program was provided. The procedure for each lesson was similar to that adopted in the baseline condition, except for the inclusion of a brainstorming session after each ten-minute writing period. After writing for ten minutes, the participants printed their work and the experimenter again commented positively on their stories. An A3 science fiction drawing was then placed on the pin-up board. The participants brainstormed ten words that were related to the picture or to their own stories. These words were written on a white board next to the pin-up board. When there were three pictures on the board, the first one was removed before another was placed on the board.

This vocabulary-based program emphasised the use of words in a context relevant to the writing process. The aims of the vocabulary-based program were to assist students in the planning of their writing by introducing vocabulary that might prompt ideas for

stories and to encourage the participants to use a broader range of words in their science fiction stories. The program featured brainstorming sessions. Galda, Cullinan and Strickland (1993) defined brainstorming as a process where students present ideas very quickly as soon as they think of them. The words and phrases that the students call out are related to a designated topic.

Phase A_2 This phase was designated as a return-to-baseline condition. The format of each lesson was identical to that followed in Phase A_1. Because the intervention introduced in Phase B had not resulted in a measurable change in the dependent variables, Phase A_2 was shortened to only two lessons.

Phase C During phase C, an interactive instructional program was introduced that provided feedback about the quality of writing. Each lesson commenced with ten minutes of writing time. The participants in the study then printed their work and the experimenter commented positively on the developing stories. She then sat at the computer with each participant in turn and identified grammatical and spelling errors on the computer screen. The participants were encouraged to correct the errors that were identified. Matthew was particularly receptive to this assistance and the other participants contributed corrections in varying degrees.

The feedback-based instruction was a one-on-one interaction between the student and the teacher. The teacher provided feedback to the student about his work. The teacher assisted the student in correcting the work on the computer screen.

After the completion of Phase C, the students were again asked to use pen and paper to write a fifteen-minute story about any aspect of space or science fiction. They were interviewed about their impressions of the program. They were asked what they would change and what they would leave the same if the program were to be offered to another group of Year 9 students.

Collection and analysis of data

In Chapter One of the report, a conceptual framework was established to identify the dimensions of quality in writing. When writing skills were assessed in the relevant literature, several qualities of writing were measured. These included fluency, spelling competence, command of an adequate vocabulary, and organizational skills (Lamb, 1972). These qualities were reflected in the dimensions of writing that were measured in the present study.

Five dimensions of writing were measured in the present study. The first of these was fluency. The writing process was considered to be more efficient if a greater quantity of writing were produced in a set period of time. The second dimension was spelling competence. The third was the number of unique words written. This was a measure of the writer's command of a vocabulary adequate to the task of story writing (Lamb, 1972). The final two dimensions of writing were the mechanics of writing and the overall competence of writing. These dimensions measured the degree of organisation of the writing and the expression of ideas so that they were meaningful to the reader (Lamb, 1972). The mechanics of writing was a measure of sentence construction, grammar and paragraphing. Overall competence of writing was a holistic measure of the quality of writing.

In the present study, a permanent product produced by the students was evaluated. In the pretests and posttests, this was assessed as a handwritten story. During the course of the program itself, the participant's typed stories were printed and set aside for marking at the end of every ten-minute lesson.

The pretest and the posttest stories produced by the participants and the comparison group were assigned scores for each of the five dimensions of quality of writing. If a student in the comparison group was absent for either the pretest or the posttest, the results were not considered. This maintained a within-subjects design, a design that ensures that individual attributes of members of the comparison group are constant in the pretest and posttest conditions. The hard copy produced by each of the participants at the end of each ten-minute writing lesson was also scored for each of the five dimensions.

In the present study, spelling was defined as a measure of the number of words spelt incorrectly for every 100 words written. Fluency was defined as the number of words written in a set period of time (Liechty, 1989). Number of unique words written was defined as the number of original words written in a set period of time. A common set of functional words was excluded. Overall competence of writing was defined as a holistic measure of the quality of the writing. Several aspects of the writing were considered in establishing this mark on a five-point scale. A table listing the qualities considered is included in Appendix C. Mechanics of writing was defined as a measure of the grammatical correctness of the writing. Sentence structure, punctuation,

grammar and paragraphing were considered when markers determined this score on a five-point scale.

Fluency. A count was made of the number of words written in each sample of work. This number was then transformed for the data analysis. These data were indicated as the number of words written in ten minutes (program samples) or the number of words written in fifteen minutes (pretest and posttest samples).

Spelling. The number of spelling errors in each sample was determined. If a word was spelt incorrectly, this was scored as one error regardless of how many letters were actually misplaced. This was converted to the number of words spelt incorrectly for every hundred words written.

Number of unique words. A set of 115 functional words was identified as being common to most of the writing samples. This set of common words is listed in Appendix B. No score was assigned to these words. Every other word included in a sample of writing was scored the first time it was used. For the pretest and posttest samples, the resulting tally was recorded as the number of unique words written in a fifteen-minute period. For the computer written samples produced across the course of the program, the resulting tally was recorded as the number of unique words written in a ten-minute period.

Mechanics of writing. The mechanics of writing variable was scored by two independent markers. Both were experienced English teachers. One of the teachers served for several years as a judge for the Nestlés story writing competition. The other

teacher had taught TEE English across a number of years. Both markers assessed each sample of work independently. The markers each used a five-point scale with 5 being the highest score and 1 being the lowest score. The work samples were sorted randomly and identifying marks were removed. Both markers considered sentence construction, grammar, punctuation and paragraphing when making an assessment.

Overall competence. The same two independent markers assessed the overall competence of each piece of writing. The work samples for this dimension were scored on a scale of one to five with five being the highest score awarded and one the lowest. When making their assessments, the markers considered the qualities listed in a table presented in Appendix C. Specifically, an overall competence score was awarded based on a consideration of whether the writing sample was logical, organised, well written, coherent, imaginative and used an effective vocabulary.

The results from the two markers were averaged. All results were tabulated and graphed. Trend lines were established using a split sample technique outlined by Wolery, Bailey and Sugai (1988). These graphs and tables formed the basis of further analysis.

Hypotheses

Similar hypotheses were proposed for each of the three participants in the present study.

Overall hypothesis:

Year nine boys with a learning difficulty provided with interactive computer-assisted instruction will improve the quality of their writing relative to that observed in a

baseline condition where a word processor was used for writing with no instructional assistance provided.

Sub-hypotheses:

(i) Year nine boys with a learning difficulty provided with a vocabulary-based computer-assisted instructional program will produce a printed record that indicates an improvement in fluency, number of unique words written, mechanics of writing and overall competence of writing relative to that observed in a baseline condition. In the baseline condition, the word processor is used without the provision of the instructional program. An increase in level and in positive slope in the ongoing data for each of the four dimensions of writing compared to the baseline will indicate improvement.

(ii) Year nine boys with a learning difficulty provided with a vocabulary-based computer-assisted instructional program will produce a printed record that indicates a reduction in the number of spelling errors made relative to the number of errors made in a baseline condition. In the baseline condition, the word processor is used without the provision of the instructional program. Improvement will be demonstrated by a decrease in the level and a more negative slope in the ongoing data for the number of spelling errors made compared to the baseline.

(iii) Year nine boys with a learning difficulty provided with an interactive feedback computer-assisted instructional program will produce a printed record that indicates an improvement in fluency, number of unique words

written, mechanics of writing and overall competence of writing relative to that observed in a baseline condition. In the baseline condition, the word processor is used without the provision of the instructional program. An increase in level and in positive slope in the ongoing data for each of the four dimensions of writing compared to the baseline will indicate improvement.

(iv) Year nine boys with a learning difficulty provided with an interactive feedback computer-assisted instructional program will produce a printed record that indicates a reduction in the number of spelling errors made relative to the number of errors made in a baseline condition. In the baseline condition, the word processor is used without the provision of the instructional program. Improvement will be demonstrated by a decrease in the level and a more negative slope in the ongoing data for the number of spelling errors made compared to the baseline.

The independent variable was the treatment intervention provided to the participants. The phases of intervention indicated levels of the treatment program. During these phases, an interactive instruction program was provided to the participants. Two interactive instruction programs were implemented and the effects of each on writing were evaluated. The first program was introduced, as Phase B. It was a vocabulary-based intervention. Pictures served as prompts for brainstorming sessions. The participants produced lists of words that related to the pictures or to their stories. The second program was introduced as Phase C. During the second program, the participants received feedback about the quality of their writing. They were

encouraged to use this information to correct their work. A model of dimensions of the independent variable is illustrated in Figure 2 on the following page.

The dependent variable for the present study was the quality of writing. Quality of writing was defined as a composite measure with five dimensions. There were five dependent variables, one for each of these dimensions. The first dimension measuring the quality of writing was fluency (the number of words written in a period of time). The second dimension measured the percentage of words spelt correctly. The third dimension was the number of unique words for every 100 words written. The fourth dimension was mechanics of writing. The fifth dimension was a measure of overall competence. The general hypothesis relating to improvement in quality of writing applied to each of the dependent variables. The dependent variables are represented diagrammatically in Figure 3.

The course of lessons consisted of four phases. The first phase was a baseline condition. The second phase was the vocabulary-based intervention. The third phase was a return-to-baseline. The final phase was the feedback-based intervention. The hypothesis stated that measurements of fluency, number of unique words, mechanics of writing and overall competence of writing would be higher in the second and fourth phases of the study compared to the baseline condition. Trend lines for these measures that were more positive in the two intervention phases than in the baseline phase would also support the hypothesis. The hypothesis would be supported if measurements of the number of spelling errors were lower in the intervention phases than in the baseline. It would also be supported if the trend line were more negative in these two phases than in the baseline phase.

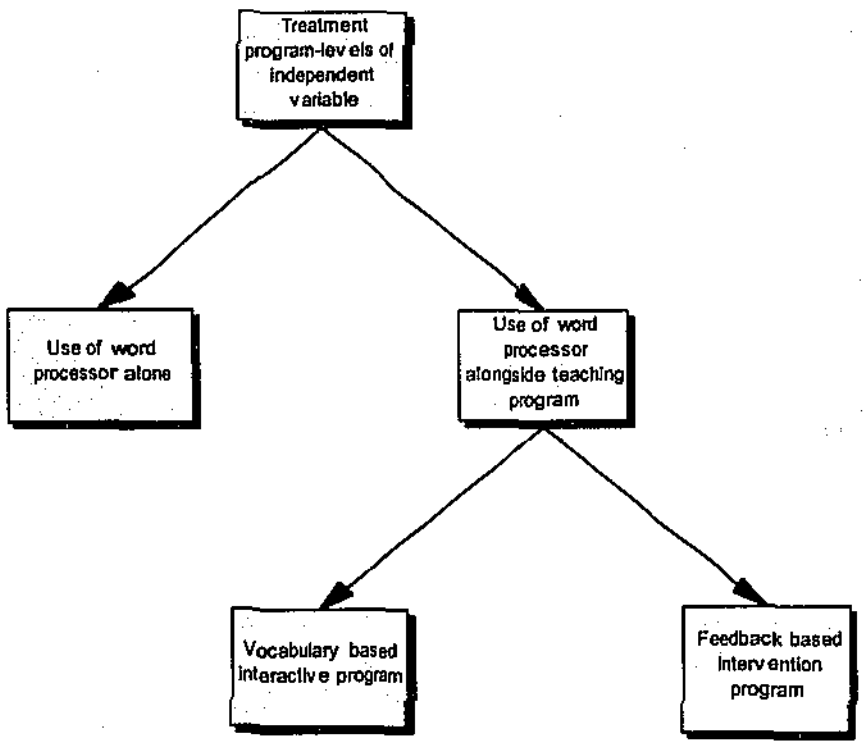

Figure 2. The treatment program. Levels of the independent variable.

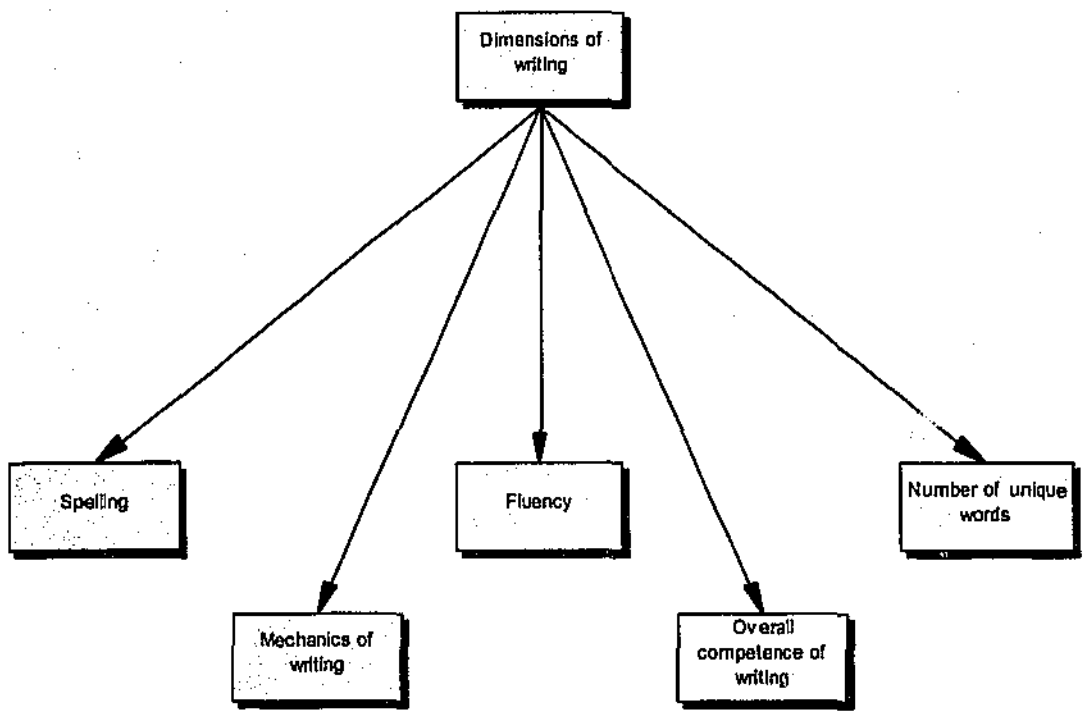

Figure 3. The dependent variables: the dimensions of writing.

Inter-rater reliability

Inter-rater reliability was calculated for the mechanics of writing and overall competence of writing.

Mechanics of writing

The correlation coefficient between the scores awarded for the mechanics of writing by each of the two markers was determined. All marked work samples (n=159) were included in the calculation of the coefficient. A correlation coefficient of 0.58 indicated a moderate relationship between the two sets of scores. However, the correlation coefficient was not considered to be the best way to determine reliability, because the scale used by the markers was restricted in nature. With one exception, the markers allocated scores across four points of the five-point scale. This very narrow range did not reflect the true congruence of the data. Visual inspection of the graphed results indicated there was a notable degree of correspondence between scores allocated by each of the markers.

Measurements were made across the baseline to determine the extent of agreement and reliability of assessments. The average score was 2.54 across the baseline (n=36). Marker A allocated a higher score than this average to 81% of samples. Marker B gave scores below this average to 78% of the samples. The average score for Marker A was 3.03. The average score for Marker B was 2.05. These observations indicate that Marker A consistently allocated higher scores than did Marker B. The magnitude of this difference was on average approximately one unit.

This difference in scores of one unit was consistent when the individual results for each of the participants were analysed separately. An analysis of marking patterns indicates that the two markers consistently assigned higher marks to particular written products and lower marks to others. When assessing Matthew's written work across the baseline (n=12), Marker A's scores were exactly one unit higher than Marker B's scores on every occasion. For both Brian's and Darren's baseline scores (n=12) for the mechanics of writing, Marker A's scores were exactly one unit higher than Marker B's scores for 75% of the sample data. Marker A's scores were within one unit of this difference on every occasion. For the combined baseline scores of all three participants (n=36), there was an 83% agreement with Marker A exactly one unit higher than W and 100% within one unit of this difference.

When considering the results obtained for the mechanics of writing, it was recognised that one marker consistently graded the work samples one unit higher than did the other. Because of this, it was decided to average the grades.

Overall competence of writing

The correlation coefficient between the scores awarded for overall competence of writing by each of the two markers was 0.53 (n=159). Again, the scale was restricted. Markers assigned grades across four points of the five-point scale.

Baseline measurements were established to determine the extent of reliability between the two markers (n=36). The average allocated mark was 2.91 across the baseline. Marker A allocated a higher score than this average to 88% of samples. Marker B gave scores below this average to 62% of the samples. The average score assigned by

Marker A was 3.17. The average score assigned by marker B was 2.65. Marker A consistently allocated higher scores than did Marker B. The difference between the scores was approximately half a unit.

As with measurements of the mechanics of writing, this difference in scores of half of one unit was consistent when the individual results for each of the participants were analysed separately. Measurements across the baseline (n=12) indicate that for Matthew, Marker A assigned a score which was exactly one unit higher than the score assigned by Marker B on 58% of the occasions. Marker A allocated a score within one unit of this measure 92% of the time. For Brian and Darren, Marker A assigned a score that was exactly one unit higher 50% of the time and that was within one unit of this measure 100% of the time (n=12). This result is consistent with data indicating that on average Marker A allocated a score that was exactly half a unit higher than that allocated by Marker B.

Measurements through all phases of the program indicate that Marker A allocated a higher score than did Marker B on 91% of all occasions (n=108). However an analysis of marking patterns indicates that, in assessing the overall competence of writing, on some occasions the two markers did not agree in assigning higher marks to particular written products and lower marks to others. This is partly a result of the half unit average difference between the two markers. Discrete scores were allocated to work samples. If one marker assigned scores half a unit higher than the other, she would allocate the mark to the nearest whole number. This would entail either the same score being assigned to both samples or one sample being scored one unit higher

than the other. Before further analysis of the data was undertaken, the grades awarded by each of the markers were averaged.

In summary, the measurements of overall quality of writing and of mechanics of writing were somewhat crude in nature. Each of the scales consisted of a narrow range of five scores. The markers consistently used only four points of the five-point scale. This had the effect of further limiting the range of scores. Furthermore, the scale was discreet in nature. The markers claimed that when they perceived the mark for a particular work sample to be intermediate between two points on the scale, they made an arbitrary decision to allocate one or other of the scores to the sample.

Chapter Four

Results

In this chapter of the report, the results of the study are tabulated, presented and analysed. The results obtained for each of the three participants during the four phases of the program are presented in separate sections of the report. Data that were collected for the three participants and for the comparison group at pretest and posttest are depicted in the final section of the report. Comparisons are made between data collected during different phases of the study and between data collected during the pretests and posttests. Trend lines are analysed. Conclusions are drawn for each of the three participants in light of the hypotheses advanced in the previous chapter.

Brian

Spelling. Brian's results indicated a marked improvement in spelling over the several phases of the study. At pretest the participant scored 5.6 errors per hundred words. At posttest the participant scored 2.9 errors per hundred words. This was a reduction in spelling errors of 48%. This data is recorded in Table 4. Table 4 is presented later in the chapter. Brian's teacher initially identified him as a very weak speller. She noted a marked improvement in his spelling towards the end of the year. At pretest the participant made more than twice as many errors as did the comparison group. At posttest the participant's score is much closer to that of the comparison group, as is apparent in Figure 12. Figure 12 is presented in Appendix D.

It is important to note that during the intervention the participant had access to spelling assistance built into the computer program, both in identifying and correcting

Table 1

Brian's Progress in Each of the Five Dimensions of Writing From Phase A to Phase C

Phase	Spelling errors/100	Fluency/ 10mn	Unique wds/10mn	Overall competence	Mechanics of writing
A_1	1.5	97.5	32.2	2.84	2.50
B	1.0	97.8	33.4	2.59	2.60
A_2	1.8	53.5	22.5	2.25	2.50
C	0.8	118.5	42.5	3.00	2.76

errors. The participant always attempted to correct errors that were indicated on the screen. The relevant information is recorded in Table 1. During the baseline there were 1.5 errors per hundred words, during Phase B there was 1.0 error per hundred words, during the return to baseline 1.8, and during Phase C, 0.8 errors. There was an improvement across the time that the program was implemented. However, the trend line for Phase C was strongly negative compared to the baseline and the mean for Phase C was lower. This information suggests that this final phase has been particularly beneficial. The hypothesis regarding spelling was supported.

Writing fluency. There was considerable improvement in writing fluency across the phases of the program. This is apparent from the information provided in Table 4. At pretest the participant wrote 144 words in 15 minutes. At posttest he wrote 245 words in 15 minutes. This is an increase in the number of words written of 70%. This change is illustrated in Figure 12, which is presented in Appendix D. Fluency was very close to that of the comparison group at pretest but more than double that of the comparison group at posttest. The trend line is strongly positive. The results during the various

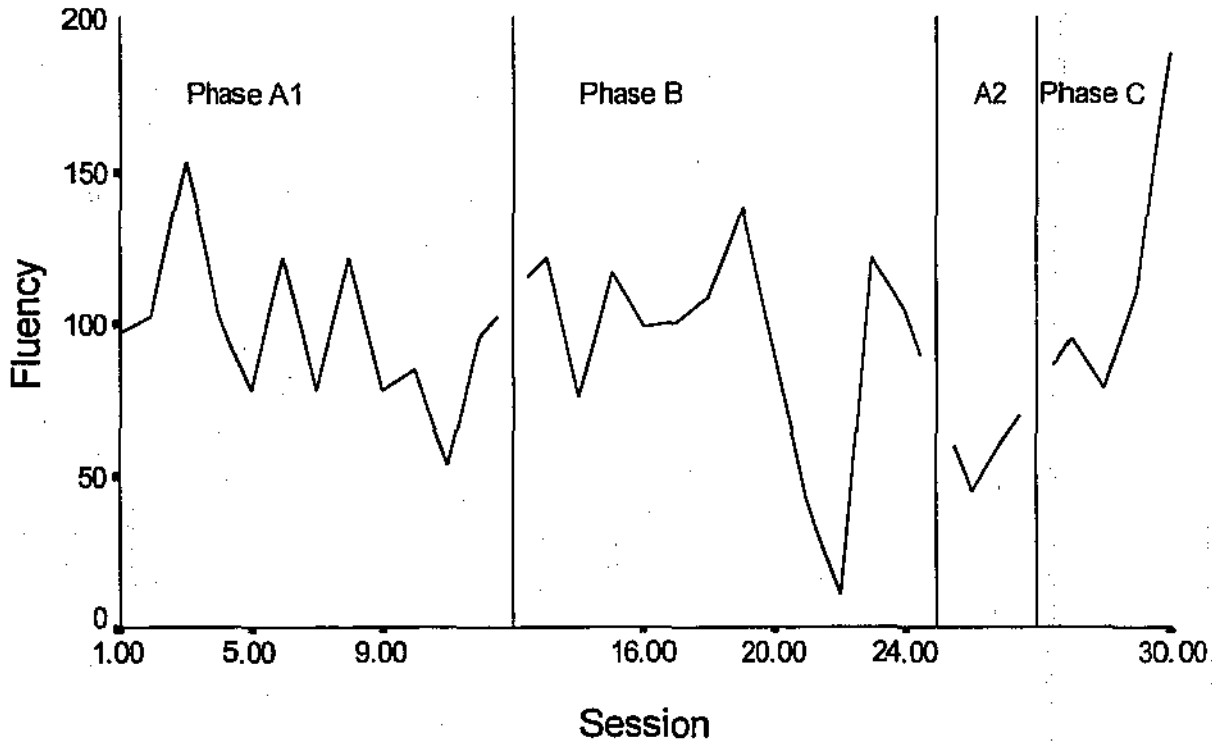

Figure 4. Fluency across all phases of the program for Brian.

phases of the program are graphed in Figure 4. The participant averaged 97.5 words in ten minutes during the baseline and 97.8 words during the first intervention. There was some regression during the return-to-baseline with 53.5 words being written in the ten-minute periods. During the second intervention, 118.5 words were written in this time period.

During the first few sessions of the program, the participant was on task and used his time effectively. In the final sessions of Phase A and across the next two phases he became distracted and exhibited off-task behaviours. These included making comments to the other participants in the study, pulling on and off his jumper, and surreptitiously starting a letter to his girlfriend. This flagging attention and interest were reflected in a steady decrease in fluency across the first three phases. This trend

was strongly reversed during the final intervention. The participant benefited from the feedback intervention as evidenced by the change in the trend line to one that is strongly positive and in the mean score that exceeded those Brian achieved earlier in the program. However, caution is called for, as this intervention was short. Figure 4 indicates the participant's progress throughout the phases of the program. It reflects this change with a strongly positive trend line in Phase C, as well as a considerable increase in mean score. The marked improvement during the second intervention lends support to the hypothesis concerning fluency.

At the end of the program, anecdotal evidence was collected regarding aspects of Brian's progress. The researcher observed Brian writing by hand during the posttest at the end of the program. Brian complained that he found the writing process slow and messy. His writing slowed him down and he frequently paused in mid-sentence. He complained that writing was difficult and tedious. In contrast, Brian claimed to find writing on the computer very easy. It was apparent that the use of the computer released Brian from uncomfortable mechanical constraints, and that the second intervention in particular was beneficial in improving fluency.

Unique words. From Phase A to Phase C, there was an increase in the number of unique words that were written in the set time period. At pretest, the participant wrote 48 unique words in 15 minutes. At posttest, he wrote 69 unique words in 15 minutes. This is an increase in the number of unique words written of 44%. This information is recorded in Table 4. At baseline, Brian wrote 32.2 words in a ten-minute period. He wrote 33.4 words in ten minutes during the first intervention, 22.5 words during the return-to-baseline and 42.5 words during the second intervention. Figure 5 illustrates

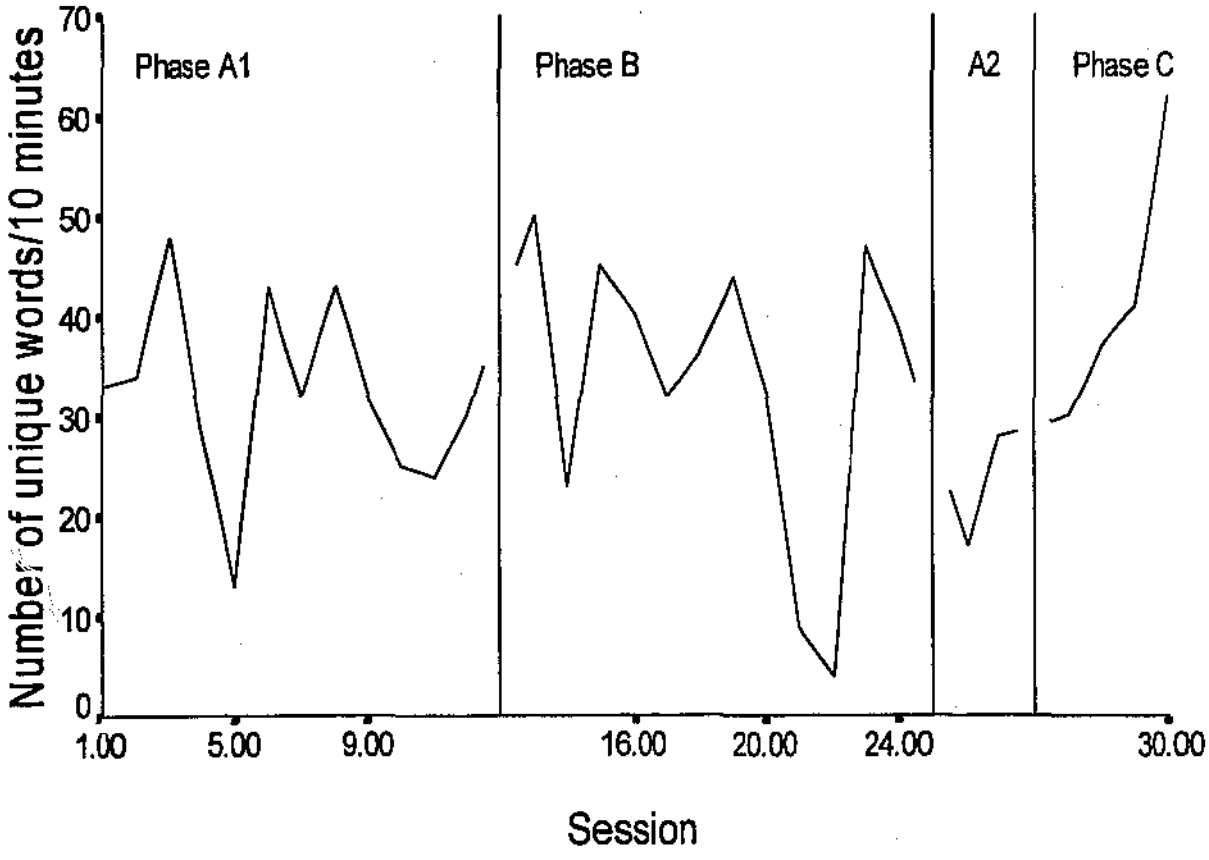

Figure 5. The number of unique words that Brian wrote in ten minutes across different phases of the program.

these data. A positive change in slope of the trend line and a higher mean during the second intervention compared to the baseline suggest that this intervention has been helpful in producing the increase. The graph shows the participant's progress throughout the program and indicates that most of the improvement occurred in the last phase where there was a change to a strongly positive trend line. The trend line during the earlier phases was relatively flat. These results support the hypothesis regarding number of unique words written in a period of time.

Mechanics of writing. The mechanics of writing showed some improvements during the five-week program. At pretest the participant scored a mark of 2.5 on the five-point scale. At posttest his score was 3.5. There was a modest improvement across the phases of the program as is apparent in Table 1. However, analysis of the difference between pretest and posttest results showed a marked improvement. This improvement is recorded in Table 4. At the start of the program, Brian's teacher stated that his written work was extremely poor. She claimed that he demonstrated a very limited understanding of sentence structure or paragraphing. His teacher reported improvements in paragraphing and sentence structure. Both of these are aspects of the mechanics of writing. The participant's grade increased from a D prior to the program to a low B at the end of the program. This change reflected improvements in several aspects of writing including the mechanics of his writing. The results of the pretest and posttest indicate that Brian benefited from the computer program. Improvements in scores were not associated with any particular phase of the intervention. Therefore, the hypothesis concerning the mechanics of writing was rejected.

Overall competence of writing. Despite the improvement in the mechanical aspects of writing, there was no clear improvement in the overall competence of writing across the course of the program. Similar scores were obtained for both the pretest and the posttest, as indicated in Table 4. Therefore the hypothesis of projected improvements in the quality of writing was rejected.

The vocabulary-based intervention produced no particular improvements in the quality of writing. Improvements in the quality of writing were not greater in this phase in comparison to the baseline for any of the dimensions of writing. While Brian

contributed positively to the brainstorming sessions, he did not use any of the suggested words in his own story. It is possible that a carry-over effect resulted from the introduction of the vocabulary-based intervention. While there was no apparent particular improvement due to the introduction of the intervention, improvements later in the program may in part have been due to the delayed effects of this intervention.

Brian was asked for feedback regarding his feelings and opinions about the completed program. He claimed to enjoy the program and that his computer story (seven typed pages) was the longest that he had ever written. He stated that he usually wouldn't undertake writing tasks because they were too much effort and were too tedious. In contrast, on the computer he found it easy to get the ideas onto paper. The participant stated that he had wanted to write his science fiction stories for three years and that the program had allowed him to do this. He considered this to be an important achievement.

Brian suggested that the school should purchase more computers so that this equipment could be used to teach English. He suggested that the school should offer "English on Computers" as an alternative course to regular English. His mother stated that she was pleased with the progress that he had made both in terms of skills and in terms of a more positive attitude. She expressed regret that the program could not be continued on a long-term basis.

Brian's teacher reported that he had a markedly more positive attitude towards his work in English and that this persisted into Year 10. Brian's grade increased at the

end of the year from a D at the end of semester one to a low B at the end of second semester. His teacher reported improvements in paragraphing, sentence structure and spelling. She believed that the individual attention would have been an important and beneficial part of the program for Brian.

Brian's results are presented in diagrammatic form in Figure 6. In summary, there were marked increases in performance in four of the five dependent variables. The hypotheses of projected improvements in spelling, fluency and number of unique words written in a period of time were supported. The study suggested that an interactive instructional program that provided feedback resulted in improvement as evidenced by improvement in these three dimensions of writing. The hypothesis of projected improvements regarding the mechanics of writing was rejected.

Improvements in the mechanics of writing were independent of level of intervention. As there were no measurable improvements in the overall competence of writing, the hypothesis regarding the overall competence of writing was also rejected.

Darren

Spelling errors. For Darren, the posttest results indicated that there was a strong improvement in spelling from phase A_1 to phase C relative to performance at pretest. At pretest the participant spelt 5.3 words incorrectly for every hundred words written. At posttest he spelt 1.3 words incorrectly for every hundred words written. The results are recorded in Table 4. This decrease in spelling errors of 76% is evident in Figure 12. The graph is strongly negative in slope when compared to the slightly negative

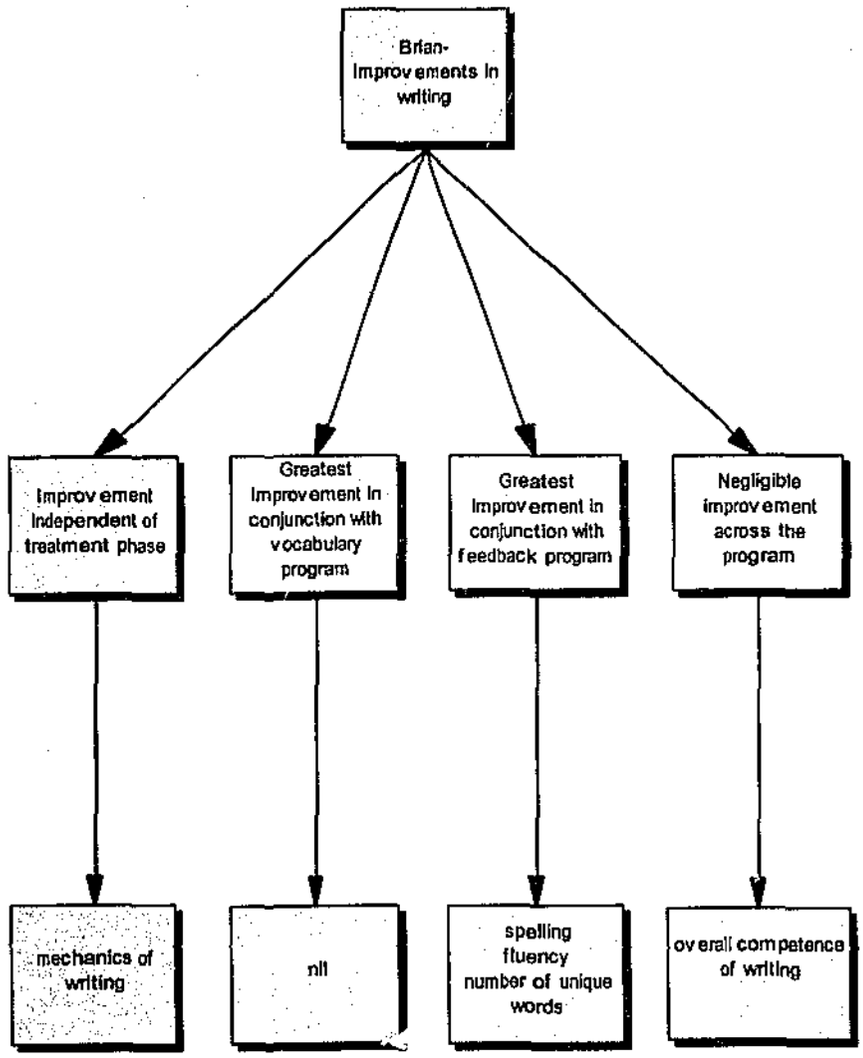

Figure 6. Brian: Improvements in writing with level of independent variable.

trend line for the comparison group over the same period. Although in the pretest Darren made over twice the number of errors made by the comparison group, in the posttest he made less errors than the average score of participants in that group.

It is important to note a difference in the conditions that were operating for Darren when he wrote on the computer as opposed to when his responses were handwritten. No assistance was provided when his responses were handwritten. When he used the computer across all phases of the study, the spelling checker feature of Word 7 identified many spelling errors. Darren always attempted to correct errors that were brought to his attention in this manner. There was an immediate improvement in spelling in the first few sessions compared to the result obtained in the pretest. This immediate improvement parallels the introduction of the spelling checker that Darren made use of continuously through all phases of the program.

There was a gradual but steady fall in the number of spelling errors made across all phases of the program. The pattern of improvement was unrelated to phase of intervention or the level of independent variable. This suggests that the improvement in the participant's spelling was more a result of the overall program than of either one of the interventions. There were 3.1 errors per hundred words during the baseline, 1.0 error per hundred words during Intervention A, 1.6 errors per hundred words during the return-to-baseline, and 1.2 errors per hundred words during Intervention B. There was some regression to a higher frequency of error in phase A_2. These results are recorded in Table 2.

Table 2

Darren's Progress in Each of the Five Dimensions from Phase A to Phase C

Phase	Spelling errors/100	Fluency/ 10mn	Unique wds/10mn	Overall competence	Mechanics of writing
A_1	3.1	63.5	23.2	2.35	2.30
B	1.0	73.3	26.5	2.68	2.50
A_2	1.6	65.5	22.0	2.25	2.00
C	1.2	82.4	30.7	2.98	3.05

Writing fluency. There were steady increases in fluency during the first two phases of the program. The trend line flattened in the final two phases. However, the improvements were maintained across these phases. During the baseline conditions the participant wrote 63.5 words in 10 minutes. The highest average, 82.4 words in 10 minutes, was obtained in the final phase. This information is recorded in Table 2. The rate of improvement was not related to either phase of the intervention. The hypothesis was rejected.

At pretest the participant wrote 150 words in a fifteen-minute period and at posttest the participant wrote 149 words in fifteen minutes. Fluency did not improve during the posttest period. This is apparent in Figure 13 which is presented in Appendix E. Analysis of the data in Table 2 indicates that when Darren used a computer across all phases of the program, there was an improvement in fluency of 30%. The production of writing, whether by means of the computer or by hand, has several common features. It was expected that the improvement in fluency on the computer might have transferred to other writing tasks. This was not the case. The participant used pen and

paper to write at pretest and posttest. Comparison of the results of these tests indicated that there was no improvement in fluency.

Observations of Darren's writing were made at posttest. The participant soon complained of a sore hand. In an effort to relieve tension, he flicked his hand around on several occasions. He also confided that he was very concerned that this written work was untidy. It was apparent that Darren found the handwriting task uncomfortable and awkward, particularly after the comparative freedom that he had experienced when using the word processor.

At the end of Semester 2 Darren was awarded a B grade in English. This was a considerable improvement on the D grade he was awarded at midyear. His English teacher reported that one factor considered in assigning him this grade was the greater quantity of written work produced in the latter part of the year. Reports from his teacher that he produced a much greater volume of writing towards the end of the year suggested that there were improvements in fluency if speed was not a factor. The teacher also reported a modest improvement in the overall quality of Darren's writing.

This anecdotal evidence suggests that there were improvements in fluency for the participant that were not apparent in the posttest. The participant produced only the same quantity of writing in a set period of time, but was more willing to persist than previously in producing longer pieces of work. The hypothesis regarding fluency was rejected. The improvement in fluency while the participant was using the computer was steady across all phases. This is apparent from the data reported in Table 2.

Mechanics of writing. Darren showed a modest improvement in the mechanics of writing from Phase A_1 to Phase C of the program. He scored 3.0 on a five-point scale at pretest. At posttest his score was 3.5. The data are recorded in Table 4. The data collected during the program are represented in Table 2. These data suggest that the improvement resulted largely from the procedures applied during the second intervention. The trend line is flat across phases A_1 and B. The return to baseline was very short and did not indicate a downward trend. The second intervention resulted in an improvement from 3 to 3.6 on the five-point scale. The trend line in this phase was strongly positive compared to the flat trend lines of the first two phases. This information is presented in Figure 7.

After completion of the intervention, Darren reported his impressions regarding the value of the program. He claimed to be surprised by how much he had enjoyed it. He took considerable pride in the stories he wrote. He particularly enjoyed sharing them with his classroom teacher. The participant did not single out either of the interventions in his assessment of the program, but claimed to enjoy the overall effects of the program. This anecdotal evidence did not support the hypotheses.

Darren was enrolled in Year 10 six months after the completion of the program. When asked by his Year 10 teacher his impressions of the program, Darren expressed the view that the program was well worth doing. He felt more confident about the mechanics of his written work and about the overall organisation of his writing. This anecdotal evidence suggests that there had been an improvement in the mechanics of writing, at least in the participant's own perceptions.

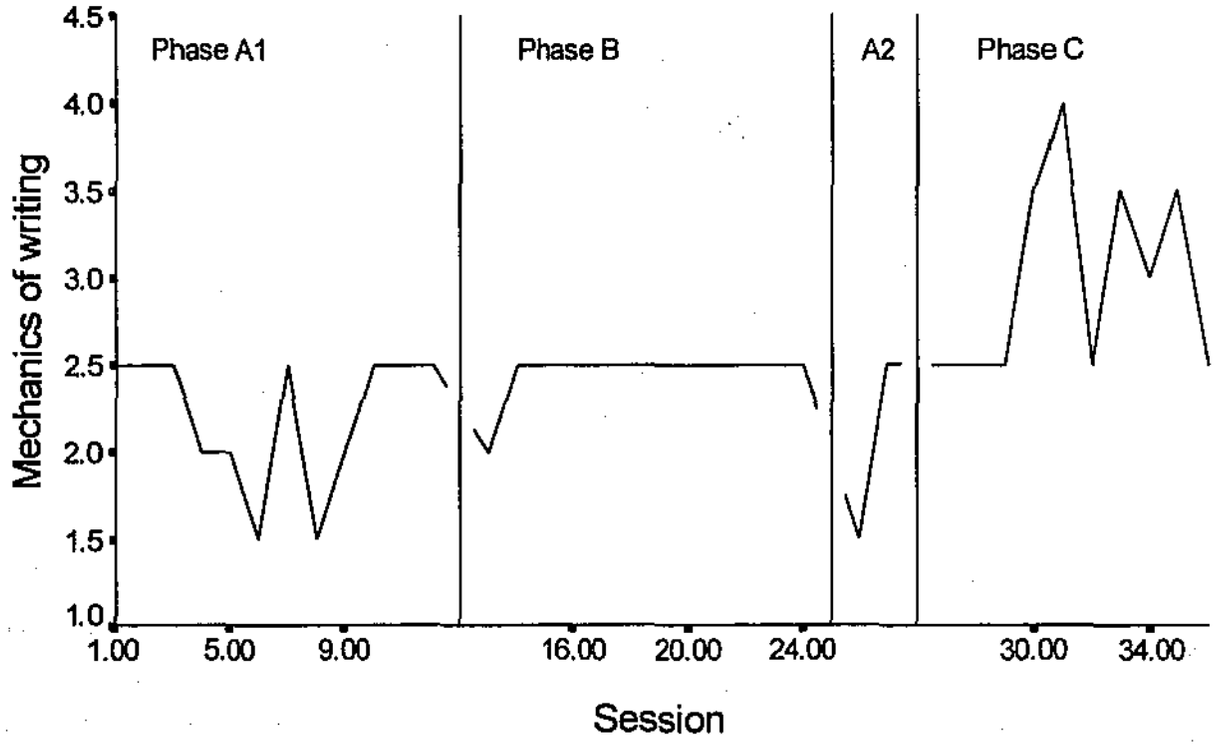

Figure 7. Darren's score for mechanics of writing across all phases of the program.

Darren's results are represented in diagram form in Figure 8. In summary, Darren demonstrated strong improvements in spelling over the period of the study. He considerably improved his fluency when using the computer. This improvement was not transferred to handwritten work. Steady improvements across the course of the program that were unrelated to any particular phase of the independent variable indicate that the hypotheses that provision of an interactive intervention would result in a greater improvement in spelling and in fluency than the use of the computer alone were rejected.

The participant demonstrated an improvement in the mechanics of writing from Phase A_1 to Phase C. His own perception six months later was that he had improved in both

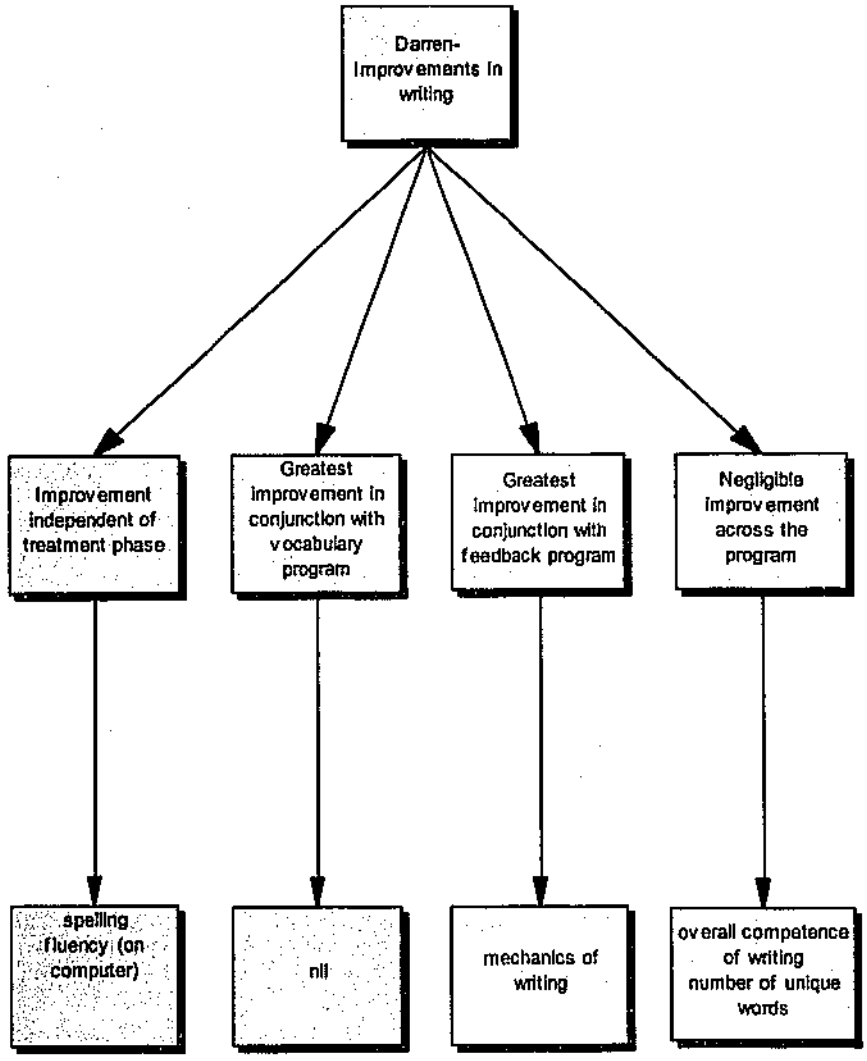

Figure 8. Darren: Improvements in writing with level of independent variable.

the mechanics and organisation of his writing. The hypothesis concerning mechanics of writing was supported for Darren by trends revealed in the data. Table 2 contains the relevant information. The feedback-based intervention resulted in greater improvements in the mechanics of writing in terms of trend and mean than did the baseline condition alone.

The program did not result in an improvement in the overall competence of writing, or in the number of unique words that were used. Consequently the hypotheses concerning overall competence of writing and the number of unique words used were rejected.

The vocabulary-based intervention did not result in greater improvements in any dimension of writing than did the baseline condition alone. However, it is possible that a carry over effect occurred and that this intervention contributed to improvements demonstrated later in the program. The vocabulary-based intervention involved a brainstorming vocabulary activity. Darren participated actively in this activity, suggesting appropriate words and commenting on the content of the pictures. However he did not use ideas based on the pictures or any of the suggested words in his own stories. Data collected across Phases A_1 to C suggest that introduction of this intervention did not result in improvements that were greater than baseline conditions with respect to any of the dimensions of writing. The hypotheses were rejected with respect to this level of the independent variable.

Spelling. Matthew made considerable gains in his spelling accuracy from baseline to final assessment. Initially his teacher had identified him as a very poor speller. She claimed that he deliberately made some letters unclear to hide uncertain spellings. At pretest Matthew spelt 10.6 incorrectly per 100 words. At posttest he produced 5.9 incorrectly spelt words per 100 words. This was a 44% reduction in errors. This improvement is apparent in Figure 12 which is presented in Appendix D.

Across the phases of the program the participant made 2.1 errors per hundred words in the baseline condition, 2.1 errors per hundred words in the first intervention, 0.8 errors in words in the first intervention, 0.8 errors per hundred words in the return-to-baseline and 2.9 errors per hundred words in the second intervention. These data are presented in Table 3. The low level of errors across the program reflects the assistance provided to the student by the spelling checker facility. The participant always made use of spelling hints provided by the word processor and was very diligent about correcting his work.

There was a small rise in the number of spelling errors in the final intervention phase compared with the baseline. This is indicated by the data in Table 3. During this phase, Matthew increased his fluency and the number of unique words used. As he wrote at a faster rate, he may not have attended as carefully to spelling. As he practised using a broader vocabulary and experimented with a wider range of words, he may have found the spelling of these less familiar words more difficult. Both of these variables increased in value across the phases of the program, but particularly

Table 3

Matthew's Progress in Each of the Five Dimensions Across the Program

Phase	Spelling errors/100	Fluency/ 10mn	Unique wds/10mn	Overall competence	Mechanics of writing
A_1	2.1	75.8	30.1	2.70	2.45
B	2.1	97.8	35.2	2.78	2.45
A_2	0.8	101	35.5	3.25	3.00
C	2.9	120.4	43.7	2.90	2.65

during the second intervention. As the participant made about the same number of spelling errors across both interventions and the baseline condition, it is concluded that improvements are the result of the overall effects of the program rather than any one particular phase. The hypothesis regarding gains in the spelling score was rejected.

Fluency. The data suggest a marked increase in fluency across the program from Phases A_1 to C. Matthew's teacher reported that he had previously experienced significant problems with fluency. He had very untidy writing that was difficult to decipher. The participant was a reluctant writer who lost marks when work was either untidy and brief or was not submitted at all. At pretest he wrote 151 words in 15 minutes. At posttest he wrote 202 words in 15 minutes. The relevant data are presented in Table 4. This represents an increase in fluency of 34%. This improvement is apparent in Figure 9. At pretest the student's fluency was similar to that of the comparison group. At posttest, he wrote almost double the number of

words written by the comparison group. This provided further evidence for his progress in this dimension of writing.

Across the phases of the program, Matthew wrote 75.8 words per ten minutes during the baseline, 97.8 words per ten-minute period during the first intervention, 101 words in the return-to-baseline and 120.4 words per ten-minute period during the final intervention. His fluency when using the computer rose from a baseline of 75.8 words in 10 minutes to 120.4 words in 10 minutes during the second intervention. This represented a 55% increase in Matthew's fluency when using a computer. These figures are presented in Table 3.

Figure 9 indicates changes in fluency across the program. It shows a positive trend line in each phase and a steadily increasing mean from Phases A_1 to C. This suggests that the effects of the computer program were beneficial while the particular interventions have not produced specific changes above that obtained from the totality of the program. The steady improvements across the course of the program are not suggestive of a carry over effect from the vocabulary-based intervention. The hypothesis regarding fluency was rejected. The researcher observed the student writing at the end of the program. He experienced difficulties with the physical aspects of writing. His posture was awkward and uncomfortable. He complained that his neck was sore because of his stiff posture.

Unique words. There was a consistent and modest increase in the number of unique words written from early to late phases of the program. The figures in Table 3

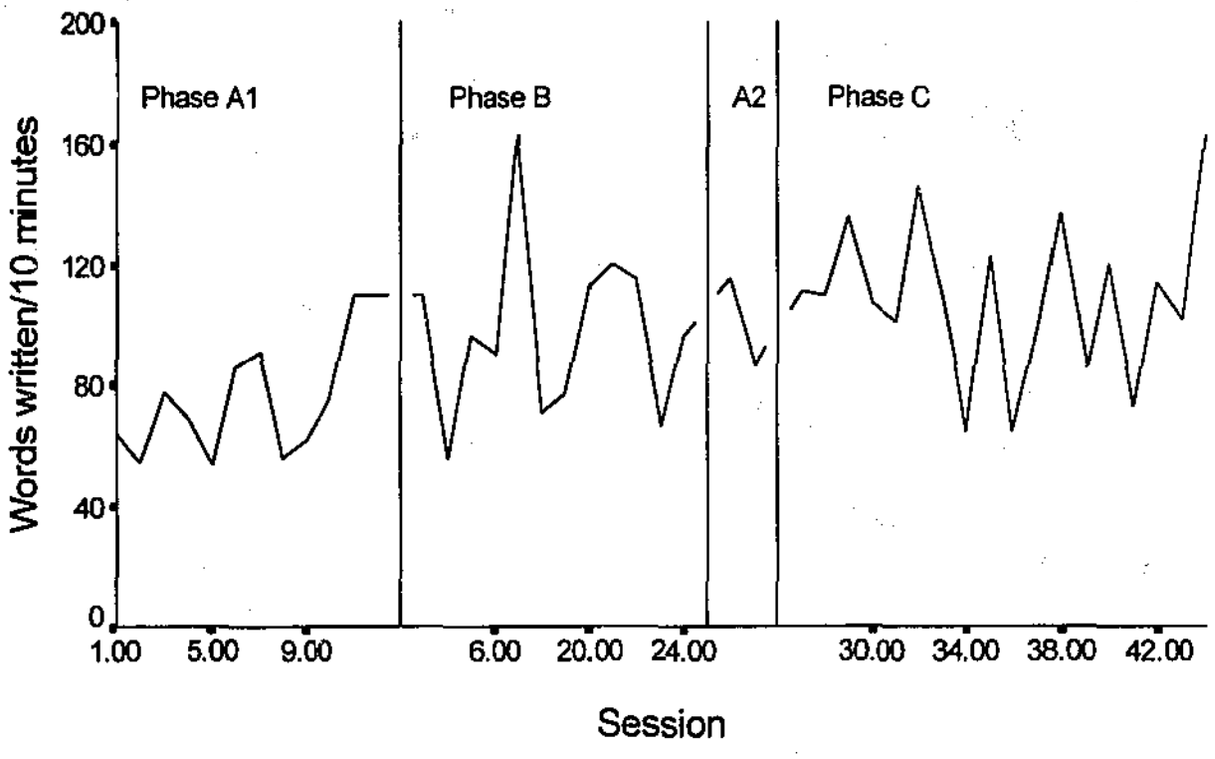

Figure 9. Fluency across all phases of the program for Matthew.

indicate the trend. Again, this appeared to be in response to the overall program, because there was a steady increase across each of the phases. At pretest the participant wrote 73 unique words in 15 minutes. At posttest he wrote unique 78 words in 15 minutes, a modest increase of 7%.

The number of unique words that Matthew wrote in different phases of the program is represented in Figure 10. This graph has a positive trend in all phases and a steadily increasing mean. The steady increases across all phases suggest that the overall program benefited him rather than either intervention in particular. The hypothesis concerning the number of unique words produced during a particular phase is rejected by these data.

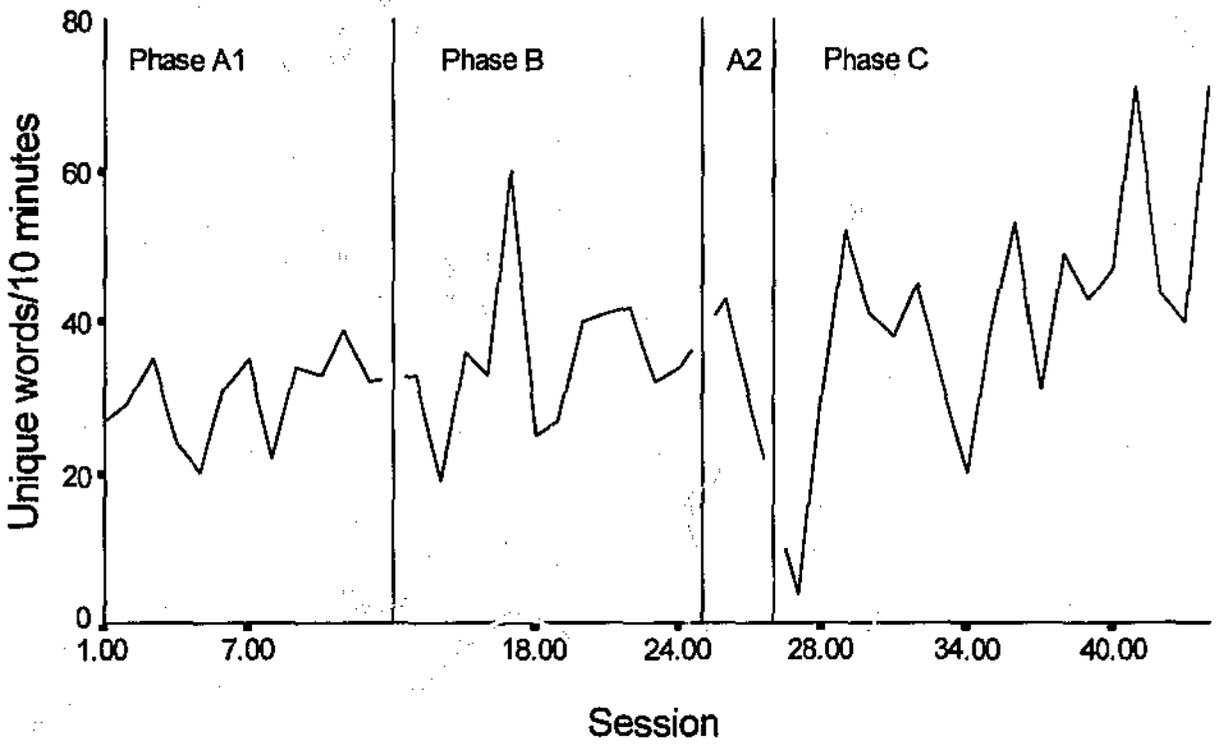

Figure 10. The number of unique words written by Matthew in ten-minute sessions across all phases of the program.

Mechanics of writing and overall competence of writing. There were no measurable improvements in the overall competency or in the mechanics of the student's writing. Similar scores were obtained at pretest and at posttest. These figures are represented in Tables 3 and 4. The hypotheses concerning these variables are rejected.

Anecdotal evidence was analysed. The experimenter asked the participant for feedback on his feelings and opinions about the program. He stated that he enjoyed the program and wouldn't suggest any changes. However, he said he would like it to continue for longer. He was very pleased with the story that he had written. Matthew's interest was great enough that he took a disk home to complete his science

fiction story in his own time. The final product was nineteen typed pages, this being quite an undertaking particularly in terms of Matthew's history as a reluctant writer.

Matthew's teacher reported that he returned to the mainstream English class with a much improved attitude to his work and that this persisted into Year 10. At the end of Year 9, his final grade improved from a D to a C. This was on the basis of improvements in the writing quality of a number of pieces of work that he submitted. The student's mother stated that she was pleased with his apparent progress but regretful that he would not receive support in a similar program into the following year.

By the end of the program, Matthew showed improvement in three dimensions of writing. These areas were spelling, fluency and number of unique words written. Improvements were not related to phase or to level of independent variable. Therefore, these hypotheses were not supported for this student. There was no marked improvement in the mechanics of writing, or in the overall competence of writing. Therefore, the hypotheses regarding these variables were rejected. Matthew's results are summarized in Figure 11.

Pretest and posttest results

The three study participants and the comparison group were tested on a writing activity at the beginning of the program and at its completion. The comparison group was comprised of 29 year nine students in a science class. The students were similar in academic ability to the participants' English classes. The students were of middle or low-level academic ability.

A feature of a single subject research design is that data is collected regarding the performance of a single individual. Comparisons are of an intra-individual nature. Experimental groups, control groups and random selection procedures were not features of this design. In keeping with the nature of single subject research, the comparison group in this study could not serve as a control group. However, information gathered about the class of students did provide a source of comparison for each of the three participants in the study. The comparison group continued with pen and paper activities in their English classes while the students taking part in the study used the word processor to write. The stories written by the three participants and by the class of students were scored on the five dimensions that comprise quality of writing. These results are recorded in Table 4.

The comparison group

The comparison group's performance declined in four of the dimensions of writing over the five-week period. This may reflect both reactive inhibition, which is a tendency for results to fall when an effortful response is repeatedly required (Reber, 1995), and a generalised loss of interest in schoolwork with the approaching end of the year. The differences in the scores between pretest and posttest scores were compared. The comparison group experienced a fall in fluency of 25% and a fall in the number of unique words produced of 18%. The comparison group experienced a fall in performance in the overall competence of writing of 14% and there was a fall of 8% in the mechanics of writing when the differences in performance were compared to pretest results. There was an improvement in only one dimension of writing, the number of words spelt correctly. There was a fall in the number of

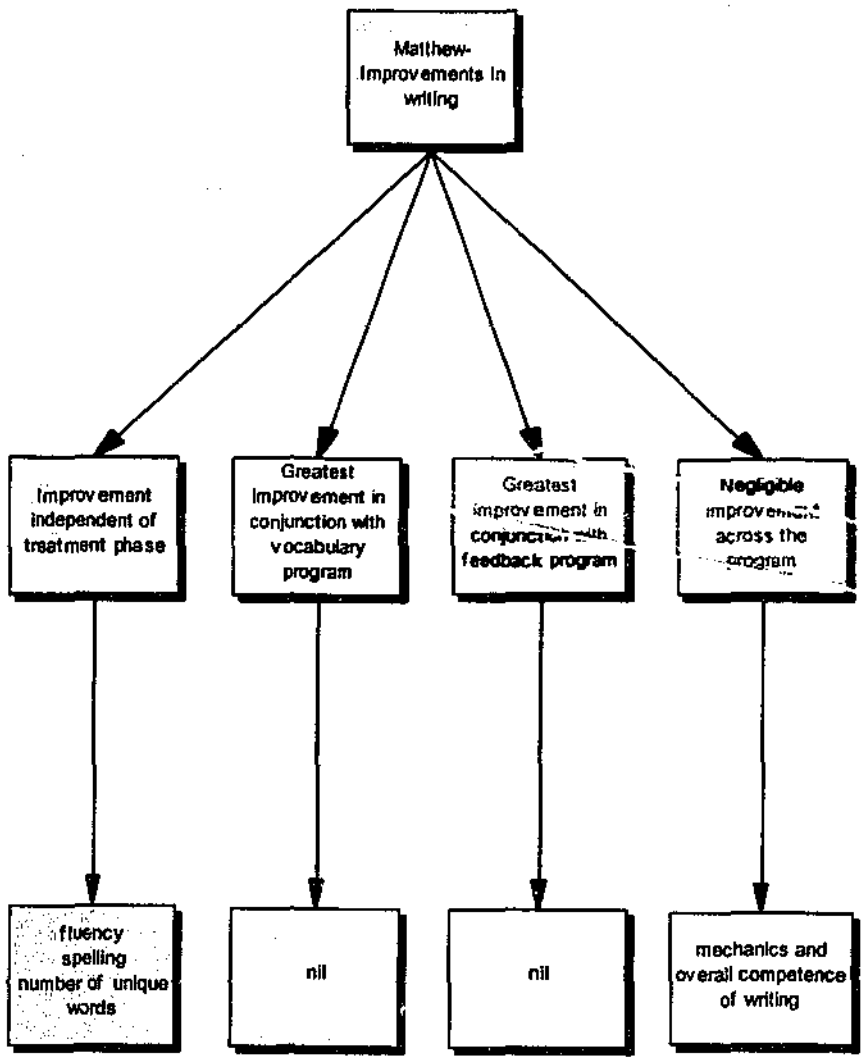

Figure 11. Matthew: Improvements in writing during different treatment phases of the program.

Table Four

Pretest and Posttest Results for each Dimension of Writing

Participant/ Pretest	Spelling errors/100	Fluency/15 mins	Unique wd/15 mins	Mechanics of writing	Overall competence
Brian	5.6	144	48	2.5	3.5
Darren	5.3	150	45	3.0	4.0
Matthew	10.6	151	73	3.0	3.5
Comp.Grp	2.6	140	44	2.5	2.8
Participant/ Posttest	Spelling errors/100	Fluency/15 mins	Unique wd/15 mins	Mechanics of writing	Overall competence
Brian	2.9	245	69	3.5	3.5
Darren	1.3	149	39	3.5	3.5
Matthew	5.9	202	78	2.5	3.5
Comp.Grp	1.9	104	36	2.3	2.4

Spelling errors, a decrease of 27% when the number of errors was compared to the total number of errors made in the pretest. The pretest and posttest results are presented in Table 4.

In Chapter Five of the report, the results of the study are formally presented. The findings of the study are discussed and reference is made to the findings of other relevant studies in the literature.

Chapter Five

Discussion

In this chapter, the results of the study are presented and analysed with respect to the hypotheses advanced in Chapter One. The findings of the study are evaluated and discussed in light of the published literature. After due consideration of the findings of the present study, some directions for future research are proposed. The strengths and weaknesses of the vocabulary-based interactive program and the feedback-based interactive program are outlined and implications for classroom practice are discussed.

Children with learning disabilities commonly experience difficulties with writing. These problems may compound as the student progresses through primary school and into the early years of high school. School performance is commonly compromised. These young people often develop negative attitudes to school in general. Programs that make use of a word processing package to improve the writing of students with learning disabilities have met with variable degrees of success. The body of research suggests that the use of an interactive teaching program combined with the use of a word processor may be efficacious in improving student's writing.

The present study, a multi-phase single subject research design, was conducted to examine the effect on writing of providing a word processing package alone compared to the effect of providing a word processing package in conjunction with an interactive instruction program.

Because of the nature of the study, a single subject research design, no explicit comparisons were made between the participants. Intra-individual comparisons were made between phases of performance for each participant. The main contrast was between the interactive program and the baseline conditions. The participants in the study were three Year 9 students with learning difficulties. Each of the three students experienced difficulties with writing. The participants were provided with a writing program across a five-week period. They used a word processor during the program to write science fiction stories of their own creation.

The program consisted of four phases. Two of these phases served as baseline conditions. During both the baseline phases, the students wrote using a word processor and no instructional program was provided. The other two phases introduced an interactive instructional program. One of these programs was vocabulary based. The second program provided "at the shoulder" feedback to the participants. Comparisons were made between the improvements in writing that the participants made during different phases of the program.

Summary of results

Across the course of the five-week program, Matthew improved in three dimension of his writing. His fluency and the number of unique words that he wrote both increased. He made less spelling errors at posttest than he had at pretest. These improvements in writing were independent of level of intervention. There were minimal improvements in the mechanics of writing and in overall competence of writing. However, anecdotal evidence suggested that there were in fact improvements in the overall competence of Matthew's writing. Matthew's grade increased from D

prior to the commencement of the program to C at the close of the program near the end of Year 9. His teacher stated that this was partly due to an increase in the quality of his writing. Overall competence of writing was a holistic measure of the quality of writing.

Matthew's attitude to writing became more positive across the course of the program. This was reflected in his willingness to complete written assignment work for his teacher. He also completed an nineteen page typed science fiction story in his own time at the close of the program.

Darren improved in two dimensions of writing from pretest to posttest. The areas where he demonstrated improvement were in the number of spelling errors that he made and in the mechanics of his writing. Darren made only one quarter as many spelling errors at posttest than he did at pretest. The reduction in the number of spelling errors that Darren made across the program was independent of the presence of an interactive program. The improvement in the mechanics of Darren's writing was greatest when Darren was provided with an interactive feedback program. A third area where Darren demonstrated improved writing was fluency when he wrote on the computer. There were strong improvements in Darren's fluency when he wrote using the word processor from Phase A to Phase C of the program. Steadily rising trend lines across all phases of the program indicated that the improvements in fluency when Darren used a word processor were not related to level of intervention. Improvements in fluency were not transferred to handwritten tasks at posttest. Although an increase in fluency was not apparent at posttest, according to Darren's

teacher, Darren completed more written tasks and produced more assignment work after the completion of the program than he did prior to the program.

Darren stated that he enjoyed using the word processor. He developed a more positive attitude towards writing by the completion of the program as is indicated by his greater willingness to complete written tasks assigned by his teacher. This attitude persisted into Year 10.

Brian demonstrated improvements in four dimensions of writing across the course of the program. Brian improved from pretest to posttest in spelling, fluency, the number of unique words written and mechanics of writing. Improvements in spelling, fluency and the number of words written were all dependent on level of intervention. There were marked improvements in these variables when an interactive feedback program was provided. Improvements in mechanics of writing were demonstrated at a steady rate across the course of the program. Improvements in this dimension were independent of phase of intervention. There is anecdotal evidence that improvements in mechanics of writing transferred to classroom-based pen and paper activities. Brian's teacher reported an improvement in sentence structure, paragraphing and spelling after the completion of the program.

Brian indicated by his comments that he thoroughly enjoyed using a word processor in the teaching program. Brian's teacher stated that he was more enthusiastic about his work in English at the end of the program. His teacher claimed that his improved attitude towards written tasks continued into Year 10.

In summary, for Matthew, the use of the word processor without a teaching program resulted in improvements in spelling, fluency and the number of unique words written. These improvements were independent of whether an interactive program was provided. The provision of interactive programs did not result in greater improvements for Matthew than access to the word processor alone.

Darren improved in three dimensions of writing. The mechanics of writing improved more if an interactive feedback-based program was provided than if he used the word processor without the provision of a program. There were improvements in spelling and in fluency when Darren wrote using the word processor. These improvements were independent of phase of intervention.

Brian benefited from the provision of an interactive feedback-based teaching program. There were greater improvements in spelling, fluency and the number of unique words written if such a program was provided. Mechanics of writing also improved. However, improvements in this dimension of writing were independent of the provision of a teaching program.

A general hypothesis regarding the use of the word processor and improvements in writing was proposed for each of the students participating in the program. The general hypothesis formed the basis of this research study. The hypothesis stated that if Year 9 boys with a learning difficulty were provided with an interactive teaching program combined with the use of the word processor, their writing would improve more than it would if they were provided with the word processor without provision of a teaching program. The hypothesis was stated formally in Chapter Three of the

report. Several sub-hypotheses were advanced. These sub-hypotheses predicted the effects on six dimensions of writing of the provision of each of two interactive teaching programs. One of these programs was a feedback-based program. The other was a vocabulary-based program.

For Matthew, the hypothesis that provision of a vocabulary-based teaching program would improve writing more than the use of a word processor alone was not supported. The hypothesis that provision of an interactive feedback program would improve writing more than the use of a word processor alone was not supported.

For Darren, the hypothesis that provision of a vocabulary-based teaching program would improve writing more than the use of a word processor alone was not supported for any of the five dimensions of writing. The hypothesis that provision of an interactive feedback program would improve writing more than the use of a word processor alone was supported for one dimension of writing, mechanics of writing.

For Brian, the hypothesis that provision of a vocabulary-based teaching program would improve writing more than the use of a word processor alone was not supported. The hypothesis that provision of an interactive feedback program would improve writing more than the use of a word processor alone was supported for three dimensions of writing. These were fluency, spelling and the number of unique words written.

Discussion of the results with reference to relevant research studies

The results obtained from each of the three participants in the study are now discussed in light of the relevant published literature.

Print production

Darren, Matthew and Brian experienced difficulties with the physical constraints of writing when they were observed writing at posttest using pen and paper. When Matthew wrote at posttest, he sat with an awkward and uncomfortable posture. He complained of pain in his neck. This pain probably resulted from his stiff posture. At posttest, Darren complained about a sore hand due to muscle tension. He was very anxious that his writing might be viewed as untidy. Brian adopted an awkward posture. He wrote slowly, pausing often. He complained that he found writing slow and difficult. MacArthur (1996) and Cochran-Smith (1991) claimed that students with learning disabilities commonly experience such problems with the physical tasks involved in the production of print. These physical problems present a real barrier to writing.

Liechty (1989) has stated that computers save time for basic writers and spare them from the discomfort of writer's cramp. The handwriting demands that were difficult for Darren, Matthew and Brian were reduced considerably when a word processor was used and letters were formed automatically (Majsterek, 1990). Because of the removal of physical constraints when each of the participants wrote using the word processor, improvements in fluency and some other aspects of writing were to be expected. All three participants increased their fluency when writing using a word processor. For Matthew and Darren, these increases were independent of the presence

of an interactive teaching program. All three students reported finding the writing process much more enjoyable when they wrote using a word processor. They were all more willing to persist with writing tasks than they had been prior to the commencement of the program. The increased amount of writing and assignment work that each of the three students produced after the completion of the program indicated transference of fluency from word processing to handwritten tasks.

At posttest, Matthew and Brian wrote more than they did at pretest. Darren wrote the same number of words in the given time period. In spite of improvements in each student's attitude to writing, the physical constraints imposed by handwriting were apparent to the researcher in the posture of each of the three students. A possible solution to this dilemma would be to lessen the burden of writing by encouraging the students to submit assignments written on the computer and by providing them with greater access to the word processor. At the completion of the program, Brian had requested that a special computer-based English class be offered to students. He wanted to use the word processor for writing on a regular basis.

Liechty (1989) suggested that students expend considerable energy mastering keyboarding skills. Each of the participants in the present study was conversant with basic word processing. Mastery of basic typing skills did not present a problem for these three students. Brian in particular was recognised as being computer proficient by his peers.

Prior to the commencement of the program, Matthew and Brian were reluctant writers. They submitted little assignment work and what they did submit was of a

poor quality. Their writing was difficult to read and full of spelling errors. Matthew, in common with many children who experience difficulties with handwriting and spelling (Outhred, 1987), developed alternative strategies to cope with writing. He wrote very little, failed to submit assignment work and mis-shaped some letters to disguise spelling errors. Brian wrote very little and structured sentences poorly. He did not correctly punctuate his work. MacArthur, Graham, Haynes and DeLa Paz (1996) explain that students with learning disabilities often display these characteristics. They frequently use a restricted vocabulary to avoid spelling more difficult words.

Spelling competence

At pretest, Darren, Matthew and Brian each experienced pronounced difficulties with spelling. This was apparent from the history of each participant as reported by their teachers and from the results of the pretests, particularly when comparison was made with the comparison group of students. Healey (1996) stated that problems with spelling characterise many students with learning difficulties. At pretest, Darren and Brian made more than twice as many spelling errors as did their peers in the comparison group. Matthew made over four times as many errors. This high rate of error was in keeping with the findings of MacArthur, Graham, Haynes and DeLa Paz (1996). In their study, MacArthur, Graham, Haynes and DeLa Paz (1996) established that students with learning disabilities misspelt two to four times as many words as did their peers.

Each of the three participants in the present study made use of the spelling correction facility on the word processor. With the help of the spelling checker, they made less

spelling errors when using the word processor than they had done when they wrote by hand. The students were usually able to identify and correct their own spelling errors by making use of the spelling checker. The ease with which they did so is in keeping with observations made by MacArthur, Graham, Haynes and DeLaPaz (1996). MacArthur, Graham, Haynes and DeLaPaz (1996) claimed that the word processor changes the task of correcting spellings from a relatively difficult recall task to the easier task of recognition.

A feature of the Word 7 word processing package was a spelling checker that underlines spelling errors on the screen. Spelling errors were brought to the attention of the writers as soon as they were made. Brian, Matthew and Darren attempted to correct spelling errors as soon as they were underlined on the screen. They used the spelling correction facility of their own volition, confidently and ably. Bangert-Drowns (1993) cautioned that use of a spelling checker might stop students from developing independent spelling strategies. The process of learning to spell may be slowed down. Majsterek (1990) believed that spelling and grammar checkers could result in dependence on the computer for spelling and could hinder development of self-correction strategies (Majsterek, 1990). A long-term study conducted by Philips (1995) with students with learning disabilities indicated that the use of spelling checkers had not resulted in an improvement in spelling. In contrast to the cautions expressed by Bangert-Drowns (1993), Philips (1995) and Majsterek (1990), a comparison of results in the pretest and posttest for each of the three students indicates that gains in spelling made during the program while using a spelling checker transferred to handwritten tasks. Furthermore, as reported by their teachers,

the gains were maintained by each of the three participants across the remainder of the year.

The findings of the present study with respect to Darren and Matthew were not consistent with those obtained in a study conducted by Dalton, Winbury and Morocco (1990). The study by Dalton, Winbury and Morocco (1990) indicated that writers who experienced the greatest difficulties with spelling had the least success when using spelling checkers. On the basis of this finding, Dalton, Winbury and Morocco (1990) claimed that all students with learning disabilities needed to be specifically taught learning strategies if they were to use the spelling checker effectively. Such specific instruction proved unnecessary for Darren and for Matthew. Brian also used the spelling checker independently. He corrected many errors, although his spelling improved more when assistance was provided. Although the three participants in the present study were all identified as poor spellers, making considerably more errors than students in the comparison group, they easily mastered the spelling checker. With the aid of the spelling checker, they were able to identify and correct most of the errors that they made. They missed a few incorrectly spelt words that were not identified by the spelling checker.

Fluency

Matthew's fluency increased across the course of the program, regardless of whether or not an interactive teaching program was provided. His fluency also improved on a long-term basis in that he was willing to spend more time writing after the completion of the program. This is apparent in his willingness to complete his science fiction story in his own time. This result complements studies by Outhred (1987), Collis

(cited in Mahsterek, 1990) and Haas (1988). These studies indicated that the use of a word processor alone would result in an increase in fluency. Outhred (1987) examined the effect of using a word processor on the writing of children with learning difficulties. He determined that the length of stories that children produced increased over the course of the program as they spent time practising writing (Outhred, 1987). Haas (1988) determined that students writing using a word processor wrote longer essays than those writing by hand. A long-term study by Collis (cited in Mahsterek, 1990) established that students with a learning disability using a word processor to write improved their spelling and developed greater fluency than a similar group of students writing by hand. None of these studies provided an interactive program.

Anderson-Inman, Knox-Quinn and Horney (1996) have stated that students with learning disabilities usually fail to complete assignment work legibly and on time. This often results in poor grades and a dislike of school in general. This was very much the case with both Matthew and Brian. Matthew achieved a D grade in English in the previous semester and he had submitted very little work. Work that had been submitted was of a very poor standard. Brian presented very little written work for assessment and was also assigned a grade of D in English. When these students completed the program, improvements in fluency for both Matthew and Brian were transferred to written tasks completed as part of the regular classroom program. Each of the two boys wrote longer pieces of work of a better standard. This increased fluency resulted in improved grades at the end of the program. Matthew's grade increased from D to C. Brian's grade increased from D to B.

Results of studies conducted by Outhred (1987), MacArthur, Graham, Haynes and DeLaPaz (1996) and Collis (cited in Mahsterek, 1990) indicated that using a word processor improved students' spelling and fluency regardless of whether or not an interactive program was provided. While this improvement was achieved independently by Darren and Matthew, Brian's improvements in spelling and fluency were related to the provision of an interactive teaching program. Bangert-Drowns (1993) cautioned that if a word processor is used without the provision of a learning program, there might be no measurable improvements in writing performance. A study of students with learning disabilities conducted by Posey (cited by Liechty, 1989) resulted in no significant improvements in writing being made by students using a word processor compared to those handwriting. No specific instructional course was provided to the students.

Mechanics of writing

Although Darren made gains in fluency on the word processor and in spelling independently of the provision of a teaching program, the mechanics of his writing improved more when an interactive program that involved "at the shoulder" feedback was provided. A possible explanation for this improvement is that Darren may have learned rules of grammar during the feedback lessons. He could see how the rules were applied in the context of his own writing. In reading through the passages with the researcher, he could see how poor punctuation and grammar could alter the meaning of sentences that he had written.

Overall competence of writing

Laframboise (1991) explained that the tasks of organising grammatical constructions, spelling, punctuation and capitalization place demands on basic writers. According to Laframboise (1991), word processing makes these tasks more manageable, freeing memory resources for higher level thinking processes. Bangert-Drowns (1993) claimed that writers are more likely to demonstrate higher order thinking processes when they are freed by the word processor from some of the simpler mechanical tasks. In the light of the claims made by Laframboise (1991) and Bangert-Drowns (1993), we could reasonably have expected the participants to progress in overall writing competence. However, none of the participants improved in overall competence of writing. These findings are similar to those discussed by Philips (1995). The long-term study conducted by Philips (1995) cited previously in this report established that reluctant writers produced greater quantities of written work when they were provided with a word processor for writing. However, as was the case with all three of the participants in the present study, the quality or overall competence of the writing did not appear to improve.

Although no improvement in overall competence of writing was apparent at posttest for any of the three participants, Matthew and Brian did demonstrate greater overall competence at the end of the program according to teacher reports. The increased quality of each of these students' writing was demonstrated in a number of pieces of work assessed by their teachers after the completion of the program. These pieces of work contributed to the improvement in English grade for Matthew from D at mid-year to C at end of the year and for Brian from D to B.

Future directions for research

From pretest to posttest, none of the participants in the present study increased the overall competence of their writing. A study by Broderick and Trushew (cited by Cochran-Smith, 1991) indicated that overall competence of writing may improve if a program is continued for a longer period of time. The authors studied the development of revision skills by students using the word processor. As the program continued over time, students became less concerned with producing error-free text and spent more time developing and using effective revision strategies. This resulted in the production of written work of a higher quality.

McNaughton, Hughes and Ofiesh (1997) highlighted the persistent nature of the problems experienced by students with learning disabilities. Even when extensive remediation was provided, the problems experienced by these students were resistant to improvement (McNaughton, Hughes & Ofiesh, 1997). If the problems experienced by students with learning disabilities are long standing, a program of longer duration may be more successful in changing writing behaviour.

Matthew, Darren and Brian are Year 9 students who were identified as reluctant writers several years ago when they attended primary school. They have experienced many years of problems with writing literacy. Their needs have not been adequately addressed by the education system. With such long-standing problems, a greater investment of time may be more productive in improving writing. The study conducted by Broderick and Trushew (cited by Cochran-Smith, 1991) and the observations made by McNaughton, Hughes and Ofiesh (1997) also suggest that a

patient approach across a longer period of time would probably result in improvements.

A future direction of research could examine the effects of a program that emphasizes the development of revision skills. MacArthur (1996) claims that effective revision strategies characterize capable writers. On the other hand, students with learning disabilities see revision as nothing more than an opportunity to correct errors. These minor changes do not affect the overall quality of their written work (MacArthur, 1996). A program designed to address the development of revision skills may result in an improvement in the overall competence of writing.

Another potential area of research is the development of pre-writing skills in conjunction with a revision program. Bahr, Nelson and Van Meter (1996) established that students with learning disabilities experience difficulties with goal setting, content development, organization of their work, evaluation of their work and revision. Addressing these skills in an explicit teaching program in conjunction with the use of the word processor may result in an improvement in the overall competence of writing.

A further possible strategy for improving the overall competence of writing is a peer-revision intervention in combination with the use of a word processor. Stoddard and MacArthur (cited by Macarthur, 1996) used a similar strategy where pairs of students with learning disabilities helped each other. The result was an improvement in overall quality of written work.

Affective gains

There were marked improvements in attitudes towards writing for all three participants in the program. This was evidenced both by statements made by the three students and by their greater willingness to participate in writing activities. Matthew took his disk home to complete his science fiction story in his own time. This was a substantial undertaking for him, his final story being nineteen typed pages. Brian also completed a longer story than he had ever written before. All three participants increased the quantity of assignment work that was submitted for assessment. This indicated that the students' new-found enthusiasm for writing had transferred to some extent to handwritten tasks set by the classroom teachers. Each of the students' teachers reported that this increased enthusiasm for written tasks persisted into Year 10.

Positive gains in the affective domain were very pronounced for all three participants in the study. Several authors report that students enjoy writing with a word processor. Philips (1995) and Hoy (1993) state that this form of writing has a motivational effect on writers who have limited writing skills. The British Dyslexic Association (1998) encourages the use of computers for students with learning disabilities. The association claims that the use of word processors by such students promotes self-esteem.

Use of a vocabulary-based intervention to improve writing

In the present study, two interactive teaching programs were introduced to students who used the word processor to write. The effectiveness of each of the two programs was evaluated. Improvements related to the introduction of the feedback-based

program were discussed earlier in this chapter. The second program was a vocabulary-based intervention when the three participants brainstormed words. Pictures with a science fiction theme served as the stimulus. This teaching program was not associated with improvements in writing for any of the three participants. All three students took part willingly in the brainstorming sessions so it is perhaps surprising that there were no apparent improvements in writing greater than improvements resulting from the use of the word processor alone. However, while they were willing to participate in this activity, the students did not transfer the words that they generated in the brainstorm into their own stories. Apparently, the three students did not see the vocabulary they generated as being relevant to their personal stories. This lack of apparent relevance could have been one factor that limited the effectiveness of the vocabulary-based intervention.

The basic writing skills of all three participants were limited. This is apparent from student results at pretest and from reports received from the students' teachers. Brian's concept of sentence structure was very restricted. All three students were poor spellers. The vocabulary-based intervention may have failed because it did not address the particular problems that the participants experienced with writing. The participants may have required explicit teaching that instructed in basic writing skills if their writing were to improve. During the brainstorming session, students generated a range of words that were written on the white board. Possibly, this process encouraged students to think about relevant vocabulary. It may have stimulated their imaginations as they shared different words that were related to the stimulus pictures. However, the process of word generation didn't address the problem of missing skills. Explicit instruction probably would have produced more gains in necessary writing

skills than open-ended instruction where the students relied on pre-existing vocabulary knowledge.

This explanation of the students' failure to improve their writing when the vocabulary-based intervention was introduced accords with the observations of McNaughton, Hughes and Ofiesh (1997). As a result of their study, these authors established that students with learning disabilities detect and correct fewer of their own errors than do their normally performing peers. The vocabulary-based program did not provide further clues and additional information that may have enabled the participants to correct their work effectively.

Use of a feedback-based intervention to improve writing

When the feedback-based intervention program was introduced, Matthew was very receptive to the help he was offered. He eagerly accepted assistance in identifying and correcting his written work. Across the course of this phase of the program, Matthew became more adept at correcting his own errors. The researcher continued to offer encouragement and to point out words that he had missed. In spite of Matthew's apparent receptivity to this phase of the program and his willingness to participate, Matthew showed no improvement related specifically to the provision of the teaching program.

Matthew indicated to the researcher that he was very keen to improve his writing and to produce a story that was free from error. Throughout the program, when grammar and spelling errors were indicated on the screen by the Word 7 program, Matthew made corrections as best he could. He gained practice writing on the word processor

and produced a clear and legible print that was easier to correct than his own hand writing. Matthew's behaviour indicated that he was very receptive to the learning cues provided by the processor during baseline conditions. Perhaps because Matthew made effective and considerable use of the spelling and grammar correction facilities, gains made during the interactive program were not measurably greater than those resulting from baseline conditions alone.

When the feedback-based intervention was introduced to Brian, be was very reluctant to accept the help that was available in this phase. His comments indicated that he found the feedback both annoying and intrusive. The researcher gained his reluctant cooperation by explaining that the interaction was an opportunity for Brian to learn grammar skills and to improve the standard of his written stories. Although Brian's attitude to the feedback intervention was negative, he benefited considerably from its provision, improving in three dimensions of writing.

Brian usually attempted to correct his own work when errors were marked on the screen by the spelling and grammar checkers. Sometimes he became impatient and added wrongly spelt words to the computer's dictionary rather than seek further for the correct spelling of a word. Brian was reluctant to use full stops and commas. During the course of the program, he wrote long sentences without punctuation breaks. When deficits in punctuation were pointed out to him during the feedback program, he was impatient about these aspects of writing. He was disinclined to address this area of his work and impatient to move on with new parts of his story.

Brian's word-processed work demonstrated a limited understanding of basic punctuation, capitalization, spelling and sentence structure. Brian's teacher had indicated that he had a very limited grasp of sentence construction. It may have been difficult for Brian to correct these errors himself from his restricted knowledge base. The direct feedback phase of the program provided him with information about rules of grammar and spelling that he could then directly apply in making his own corrections. Frequent feedback from the researcher also helped Brian to stay on task. Earlier in the program, Brian had sometimes been inattentive. His concentration strayed from the task at hand after a short period of time. Knowing that he would receive feedback every few minutes resulted in him concentrating more on the task at hand.

Darren responded positively to the feedback program. Sitting alongside the teacher, he attempted to make many corrections to his work himself. Darren improved in the mechanics of writing during this phase of the program. He may have benefited from the provision of information about the application of the rules of grammar to specific situations. He may have applied skills learnt in this one-to-one feedback situation to his own writing.

The results of this study cannot be applied generally to the broader student population. The particular situations of the three individuals who participated in the study are unique to these individuals. The assumption should not be made that findings peculiar to an individual student in a single subject research design can be applied at large to students in other settings. Notwithstanding these reminders, teachers may gather information and try strategies that proved to be successful with other students in other

settings. Some of these strategies may prove to be helpful new tools in their own classrooms, while others may prove less appropriate and be modified or abandoned.

The findings of the present study indicated that, although Brian resisted feedback and correction in a one-to-one situation, he nevertheless benefited from its provision. A teacher who is aware of this finding regarding Brian might avoid making a premature assumption based on student behaviour that a feedback program was unlikely to yield benefits. On the other hand, Matthew was very receptive to the provision of a feedback program. The results indicated, however, that he benefited just as well from the use of the word processor alone without the provision of such a program.

Conclusion

Students with learning disabilities commonly experience problems with writing. In this study, the effects on writing of the provision of an interactive teaching program in conjunction with the use of a word processor were evaluated. The study was a multi-phase single subject research design study. Three Year 9 students participated in the study.

Each of the participants in this study improved his writing in at least one dimension of writing independently of the provision of an interactive teaching program. Matthew improved in three dimensions of writing, these being fluency, spelling and number of unique words written. Darren improved in two dimensions of writing, these being spelling and fluency when he wrote using the computer. Brian improved in one dimension of writing, independently of the provision of an interactive teaching program. This dimension was mechanics of writing.

None of the participants in the study benefited from the introduction of a vocabulary-based interactive learning program in combination with the use of the word processor. A possible explanation is that the participants did not find this particular program relevant to their own writing. Another explanation is that the program did not address deficits in basic writing skills.

An interactive teaching program that provided feedback to the participants was introduced in combination with the use of the word processor. Matthew participated eagerly in this phase of the program. However, improvements in his writing were no greater than improvements resulting from the use of the word processor alone. Brian improved in three dimensions of writing in response to the introduction of the program. These dimensions were spelling, fluency and number of unique words. Darren improved in one dimension of writing in response to the introduction of the program. This dimension was mechanics of writing. The students' affective responses to the program were not an indicator of its effectiveness.

When participating in the interactive feedback program, students had the opportunity to revise rules of spelling, grammar and punctuation as these arose during the correction process. Each student received individual attention that encouraged concentration on the task at hand. These two factors may have contributed to the success of the program, particularly with respect to Brian.

The three participants in the study enjoyed using the word processor. Strong improvements in their attitudes to writing were transferred to the production of

handwritten work. After the completion of the program, all three student participants produced more assignment work and improved their English grades.

References

Alberto, A. A., & Troutman, A. C. (1995). Applied behavior analysis for teachers. New Jersey: Prentice-Hall.

Anderson-Inman, L., Knox-Quinn, C., & Horney, M. A. (1996). Computer-based study strategies for students with learning disabilities: Individual differences associated with adoption level. Journal of Learning Disabilities, 29 (3), 461-484.

Bahr, C. M., Nelson, N. W., & Van Meter, A. M. (1996). The effects of text-based and graphics-based software tools on planning and organizing of stories. Journal of Learning Disabilities, 29 (4), 1996, 355-370.

Bangert-Drowns, R. L. (1993). The word processor as an instructional tool: A meta-analysis of word processing in writing instruction. Review of Educational Research, 63 (1), 69-93.

Cochran-Smith, M. (1991). Word processing and writing in elementary classrooms: A critical review of related literature. Review of Educational Research, 61 (1), 107-155.

Collier, R. M. (1983). The word processor and revision strategies. College Composition and Communication, 34 (2), 149-155.

da Fonseca, V. (1996). Assessment and treatment of learning disabilities in Portugal. Journal of Learning Disabilities, 29 (2), 114-118

Dalton, D. W., & Watson, J. F. (1986, January). Word processing and the writing process: Enhancement or distraction? Paper presented at the annual convention of the Association for Educational Communications and Technology, Las Vegas, NV, January 16-21. Las Vegas: Association for Educational Communications and Technology. (ERIC Document Reproduction Service No. ED 267 763)

Dalton, B., Winbury, N. E., & Morocco, C. C. (1990). "If you could just push a button": Two fourth grade boys with learning disabilities learn to use a computer spelling checker. Journal of Special Education Technology, 10 (4), 177-191.

Duin, A. H., & Graves, M. F. (1987). Intensive vocabulary instruction as a prewriting technique. Reading Research Quarterly, 22 (3), 311-330.

Emmitt, M., & Pollock, J. (1991). Language and learning. Australia: Oxford University Press.

Galda, L., Cullinan, B. E., & Strickland, D. S. (1993). Language, literacy and the child. USA: Harcourt Brace College Publishers.

Graves, D. H. (1991). Build a literate classroom. Toronto: Heinemann Irwin Publishing.

Haas, C. (1988). How the writing medium shapes the writing process: Effects of word processing on planning. Pennsylvania: Carnegie Mellon University. (ERIC Document Reproduction Service No. ED 309 408)

Harris, T. L., & Hodges, R. E. (1995). The Literacy Dictionary. The Vocabulary of Reading and Writing. USA: International Reading Association.

Healey, K. (1996). Learning disabilities, issues for the nineties. Australia: The Spinney Press.

Heenan, J. E. (1987). Writing: Process and product. New Zealand: Longman Paul Limited.

Hoy, T.A. (1993). Comparison of teaching methods in freshman composition classes for learning disabled students at San Antonio College. Texas: San Antonio College. (ERIC Document Reproduction Service No. ED 368 124)

Kamler, B., & Woods, C. (1987). Two Pathways to Literacy. Australia: Australian Association for the Teaching of English.

Kerchner, L. B., & Kistinger, B. J. (1984). Language processing/word processing: Written expression, computers and learning disabled students. Learning Disabilities Quarterly, 7, 329-335.

Kurth, R., & Stromburg, L. J. (1984, December). Using word processing in composition instruction. Paper presented at the Annual Meeting of the American Reading Forum, December 8-10. Orlando: American Reading Forum. (ERIC Document Reproduction Service No. ED 251 850)

Laframboise, K. L. (1991). The facilitative effects of word processing on sentence-combining tasks with at-risk fourth graders. Journal of Research and Development in Education, 24 (2), 1-8.

Lamb, P. (1972). Guiding children's language learning. Iowa: WM. C. Brown Company Publishers.

Levine, T., Conitsa-Schmidt, S., & Zellermayer, M. (1996). Student perceptions of classroom climate in a communicative and computer-supported approach to writing instruction. Journal of Research and Development in Education 129 (2), 94-102.

Lichtenstien, N. (1996). The effect of word processing on writing achievement. New Jersey: Kean College of New Jersey. (ERIC Document Reproduction Service No. ED 394 146)

Liechty, A. (1989). The efficacy of computer assisted instruction in teaching composition. Indiana: Process Approach (Writing). (ERIC Document Reproduction Service No. ED 314 023)

MacArthur, C. A. (1996). Using technology to enhance the writing processes of students with learning disabilities. Journal of Learning Disabilities, 29 (4), 344-354.

MacArthur, C. A., & Graham, S. (1987). Learning disabled students' composing under three methods of text production: Handwriting, word processing and dictation. The Journal of Special Education, 21 (3), 22-42.

MacArthur, C. A., Graham, S., Haynes, J. B., & DeLaPaz, S. (1996). Spelling checkers and students with learning disabilities. Performance comparisons and impact on spelling. Journal of Special Education, 30 (1), 35-57.

MacArthur C. A., Graham, S., Schwartz, S. S., & Schafer, W. D. (1995). Evaluation of a writing instruction model that integrated a process approach, strategy instruction and word processing. Learning Disability Quarterly, 18 (4), 278-292.

MacArthur, C. A., & Shneiderman, B. (1986). Learning disabled students: Implications for instruction and software evaluation. Journal of Learning Disabilities, 19 (4), 248-253.

Majsterek, D. J. (1990). Writing disabilities: Is word processing the answer? Intervention in School and Clinic, 26 (2), 93-97.

McNaughton, D., Hughes, C., & Ofiesh, N. (1997). Proofreading for students with learning disabilities: Integrating computer and strategy use. Learning Disabilities Research and Practice, 12 (1) 16-28.

Morocco, C. C., & Neuman, S. B. (1986). The use of the word processor in assisting children's writing development. Educational Review, 38 (2), 169-187.

The National Dyslexic Association of the United Kingdom (1998). (on-line). Available World Wide Web http://www.bda-dyslexia.org.uk (1998, March 23).

Outhred, L. (1987). To write or not to write: Does using a word processor assist reluctant writers? Australia and New Zealand Journal of Developmental Disabilities, 13 (4), 211-217.

Pearson, H., & Wilkinson, A. (1986). The use of the word processor in assisting children's writing development. Educational Review, 38 (2), 169-187.

Philips, D. (1995). Using the word processor to develop skills of written expression. Final report. Evaluation of exploratory studies in educational computing. Study 6. New Zealand: New Zealand Council for Educational Research. (ERIC Document Reproduction Service No. ED 387 820)

Reber, A. S. (1995). The Penguin Dictionary of Psychology (2nd ed.). England: Penguin Books.

Shean, R. (1993). The education of students with learning disabilities and specific learning difficulties. Western Australia: State Government Taskforce on the Education of Students with Disabilities and Specific Learning Difficulties.

StMichael, (1983). Beyond the stars. Tales of adventure in time and space. Great Britain: Octopus Books.

Storeygard, J., Simmons, R., Stumpf, M., & Pavloglou, E. (1993). Making computers work for students with special needs. Teaching Exceptional Children, Fall, 22-24.

Wolery, M., Bailey, D. B., & Sugai, G. M. (1988). Effective teaching: Principles and procedures of applied behavior analysis with exceptional students. USA: Allyn and Bacon.

Yau, M. (1991). Potential and actual effects of word processing on students' creative writing process. (Report No.198). (ERIC Document Reproduction Service No. ED 331 044)

Appendix A

Letters were sent to the participants, to their parents and the principal seeking permission for the Year 9 students to take part in a five-week computer based writing program. Copies of the letters are provided on the following three pages of this report.

Dear student

I am inviting you to participate in a writing program. The program involves you working on a computer in a small group situation for ten English lessons across a five-week period. The aim of the program is to help you to improve your writing skills while using the computer. This program is a component of my Masters degree through Edith Cowan University. If you take part in the program, you will be free to withdraw at any time. If you choose to take part, I believe that you will find the course interesting and enjoyable and that it will help you to improve your writing skills.

Yours sincerely

C. Cropley
Teacher, Woodvale Senior High School

✂----------

I, _____, have read the information above and I consent to take part in this program, realising that I may withdraw at any time.

_____ _____ _____

Name Signature Date

Dear parent or guardian,

I am conducting a research program to help students to improve their writing. The students taking part in the program will use a word processor to write stories. They will be given support and instruction during the writing process and will work in a small group.

I am writing to ask for your consent to include your child in this program. No names will be reported in this research program. If you agree to your child participating, your child will be withdrawn from the regular English classroom for ten lessons during Term IV, over a five-week period. I expect that the students will enjoy this computer-based course, and that they will benefit greatly from the program, writing more confidently and improving their literacy skills.

If you have any questions about this program, please phone me (9309 087) and I will be happy to answer any questions. When the program is completed, I will advise you as to your child's progress in writing.

Yours faithfully,

Cecily Cropley
Teacher, Woodvale Senior High School

✂----------

I have read the information above and any questions I have asked have been answered to my satisfaction. I consent to my child _____ participating in the research, realising that I may withdraw at any time.

I agree that the research data gathered for this study may be published provided my child is not identifiable.

_____ _____ _____

Name Signature Date

Mr John Feutrill
Principal
Woodvale Senior High School

11th September, 1998

Dear John

I would like your permission to conduct a writing program with a group of three year nine students who experience problems with literacy. The program combines interactive instruction with the use of the word processor and would run for five weeks of Term IV. For the duration of the program, students would withdraw from their English classes for two lessons a week to take part in a small group teaching program which makes use of the word processor. I have had some preliminary discussions with Toni Strong to ensure that this program is compatible with the aims of remedial education in this school.

The program examines the effects of students receiving assistance with planning work and of providing them with immediate feedback. Students use a word processor to write. This frees them from some of the mechanical problems of print production allowing them to focus on other aspects of expressive writing.

This program forms the basis of research for my Masters thesis and is supervised by Professor Peter Cole of the Faculty of Education at Edith Cowan University. My area of interest is children with special needs and my particular interest is children in the regular classroom who struggle with writing.

Kind regards

Cecily Cropley

Appendix B

A List of One Hundred and Fifteen Common Functional Words

The writers in this study commonly used the words listed in this appendix. Therefore, these words were not included when a count was made of the number of unique words used by students in their writing passages.

a, about, all, also, an, and, am, are, as, at, away

be, because, been, being, but, by

can, could, couldn't

did, didn't, do

each, ever, everybody, everyone, everything, everywhere

for, from

get, gets, getting, go, goes, going, got, gotten

had, hadn't, have, has, he, her, here, him, himself

I, I'd, I'll, I'm, I've, in, into, it, its, it's

made, make, makes, many, more, much, my

no, not, nowhere

of, off, on, once, one, other, others, out, over

so, some, such

that, that's, the, their, them, then, there, these, they, those, to, took

until, up, upon, us

was, wasn't, way, we, went, were, what, when, where, which, who, will, with, would, wouldn't, why

you, your, you've

Appendix C

A Scale Used as a Guide to Markers when Evaluating the Overall Competence of Writing.

The markers determining the overall competence of writing were provided with a copy of the following table. This table was based on the "set of composition quality scales", a table produced by Duin and Graves (1987). The writers used the table as a guide to establish a single score for overall competence. The scoring system was based on a five-point scale. The highest rating was five and the lowest rating was one.

Table 5

Overall Competence of Writing

Lowest score	Intermediate score	Highest score
Illogical	----------→	Logical
Disorganised	----------→	Organised
Poorly written	----------→	Well written
Incoherent	----------→	Coherent
Weak content	----------→	Strong content
Poor vocabulary	----------→	Good vocabulary
Unimaginative	----------→	Imaginative
Writer doesn't appear intelligent	----------→	Writer appears intelligent

Appendix D

Graphical Representation of Pretest and Posttest Data

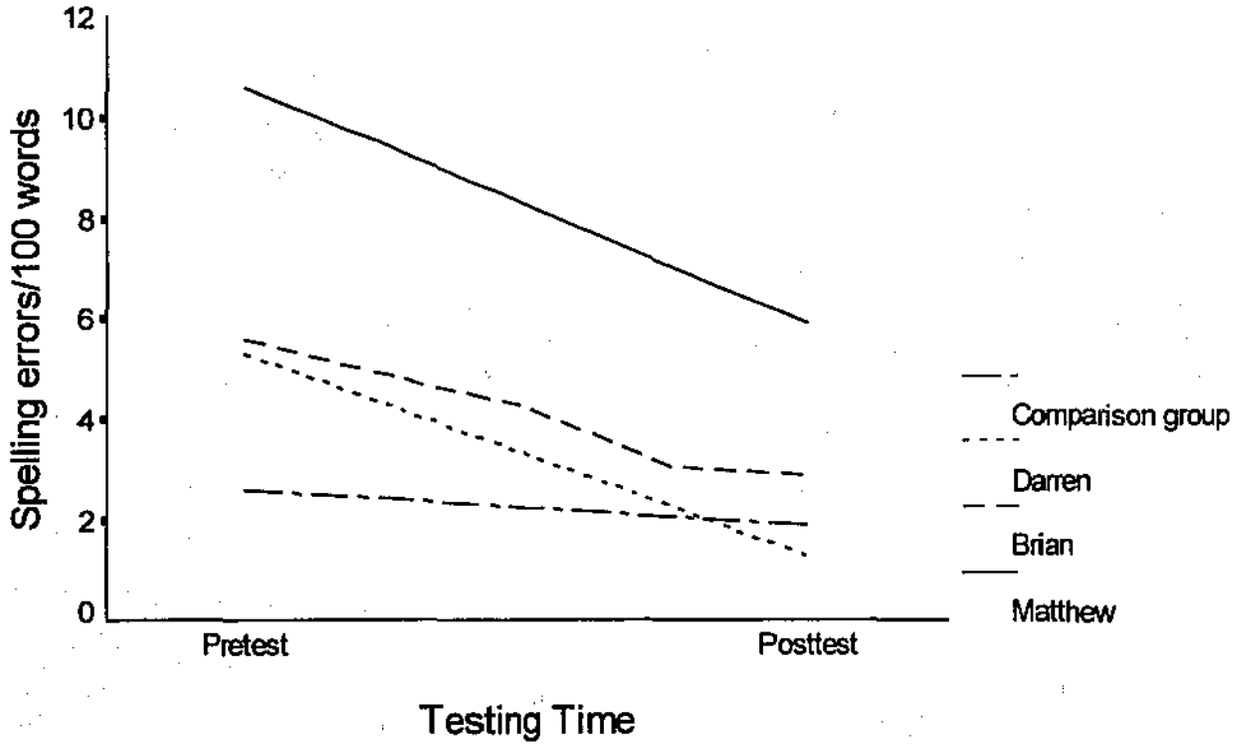

Figure 12. Number of spelling errors per 100 words written in the pretest and the posttest for each of the study participants and for the comparison group.

Appendix E

Graphical Representation of Pretest and Posttest Data

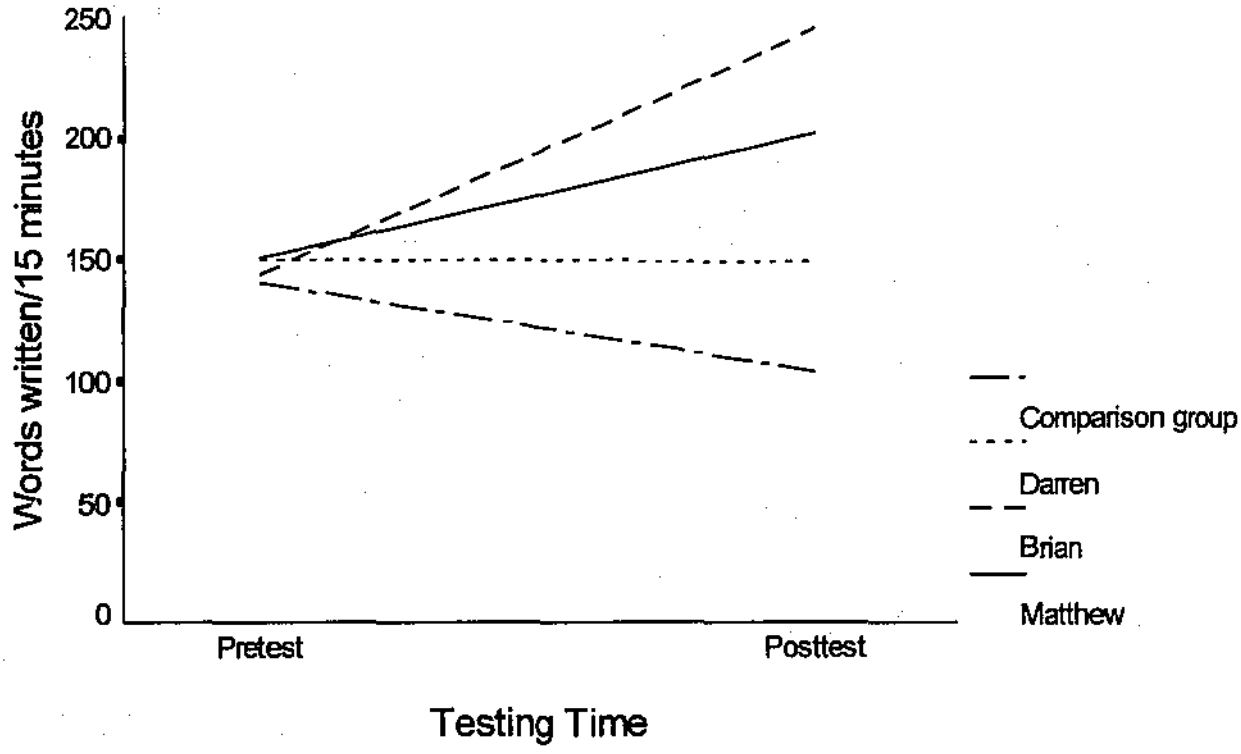

Figure 13. Number of words written in 15 minutes in the pretest and the posttest for each of the study participants and for the comparison group.