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Acquisition of Keyboarding Skill: A Single Subject Design

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Abstract

The effectiveness of computer-assisted instruction, mnemonics, and constant time delay procedures to teach basic keyboarding skills and letter/sound correspondence was investigated in this study. The study was done with an elementary-school child who has been described as having a mental disability and a speech language impairment. He has been diagnosed with Robinow Syndrome and Attention Deficit Hyperactivity Disorder. Research has shown that computers are an effective method for teaching students with disabilities who have difficulties with paper-and-pencil tasks. Data were collected twice a week over a six-week period. The results indicated that mnemonics was effective in teaching letter/sound correspondence. However, no conclusions were drawn for the use of computer-assisted instruction and the constant time delay procedure in teaching basic keyboarding skills.

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THANK GOODNESS I FINISHED. THANK YOU.

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Acquisition of Keyboarding Skills: A Single Subject Design

Teachers today are exploring uncharted territory and by doing so are playing a key role in helping the U. S. educational system make the transition from the Industrial Age to the Information Age. The use of computers has caused an educational revolution, however many people still are not sure whether children should use computers in school. Computers have been used since the early 1960s in educational settings but not for teaching. The first use of computers by educational institutions coincided with the introduction of second-generation computers. It was during this time that large universities began using computers for administrative purposes and student record keeping (Alessi, Trollip, 1985). People began using computers for instructional research such as project PLATO at the University of Illinois, which began in 1960 with the goal of designing a large computer-based system for instruction. IBM, soon after, introduced Coursewriter, a programming language designed for preparing instructional materials on IBMs large computers. Third-generation computers became available in increasing numbers and at lower cost through the first half of the 1970s. More and more school systems and universities began to use computers for administrative purposes.

During the mid-1970s, the first microcomputer was developed (Sutton, 1991). Unlike the large, expensive computers, they could be used by only one person at a time. Radio Shack, Commodore Business Machines, and Apple Computer introduced the TRS-80, PEP, and Apple computer, respectively. With the introduction of these microcomputers, the microcomputer revolution was ushered in. Due to the development of these computers it became possible for individual public-school teachers, small public schools, and individual university researchers to buy computers and start using them for educational purposes.

The introduction of computers in the educational setting brings up the question of whether or not children should use computers in schools. Many professional educators answer this question affirmatively. Society is changing rapidly, and many of these changes are rooted in new ways of generating, storing, communicating, and using information. More and more parents, teachers, and children believe that by learning about computers and how to use them , they will be better prepared to survive and to enjoy economic security and well-being in the changing world. Some believe that one must learn to take control of the machine before it takes control of them. Therefore, the answer to the question "Should children use and learn computers in school?" according to one researcher is "yes" (Hunter, 1983).

By 1981, the majority of secondary schools had at least one microcomputer; by 1985 more than 90 percent of all public schools had at least one microcomputer. It was estimated by the end of the 1980s, 2.4 million computers were in use in schools (Sutton, 1991). As of 1990 over 500,000 microcomputer in United States schools are being used exclusively by students with disabilities (Tenney, & Osguthorpe 1990). It is important to remember that these are just estimates. Students with disabilities and without disabilities may also have access to computer labs within their school or at home.

Before the introduction of computers in the classroom, the typical instructional process included (1) the instructor presenting information to students; (2) the teacher guiding the student's first interaction with the material; (3) the student practicing the material to enhance fluency and retention; and (4) the teacher testing students to determine what they should do next (Alessi, & Trollip 1985). These processes can also be accomplished by computer-based instruction. For example, it may present initial information, after which the student would receive guidance and practice through workbooks. Another possibility would be that the student learns the initial information from a lecture, and then uses the computer to practice the material to fluency.

Computers are currently used for instruction in the following ways: tutorial instruction, drills, simulations, instructional games, tests, problem-solving, teaching tools, games, intelligent computer-assisted instruction, or computer-controlled videos. Tutorial instruction, the most basic form of computer-based instruction, teaches by carrying on a dialogue with the student. It presents information, asks questions, and makes the decision whether to review or move on based on the student's comprehension. In a drill, questions or problems are presented repeatedly until the student answers or solves them at some predetermined level of proficiency. Computers can considerably enhance the effectiveness, efficiency, and enjoyment of drills; through animation, color, and sound. This variety in instruction directs student's attention toward the academic task instead of distracting from it (Alessi, & Trollip 1985).

Simulations are one of the more creative approaches to computer-based instruction. Instructional simulations are computer programs that imitate a phenomenon in order to teach students about it. Instructional games are also an important instructional methodology. There are also computer games purely for entertainment . These games can be used as rewards for educational progress. Computer tests may improve the quality of tests administered and free the teacher from administering and scoring tests. They can improve the quality of tests by improving the accuracy with which they measure student knowledge, which is an important component in the instructional process. Problem-solving skills can be taught to students by way of programming computers. The "problem" is what you want the computer to do, and the "solution" is the program you enter into the computer to make it do what you want (Alessi, & Trollip 1985).

Many computer programs such as word processing programs and spreadsheets are being used for teaching. Word processing programs permit the student to draft and revise a paper more easily than with pen and paper. Electronic spreadsheets are used in mathematics for calculations, and in science to collect laboratory data and do laboratory calculations.

So far the research has summarized a number of ways computer may be used in instruction, but what is really important to know is whether these are effective in improving student performance. Kearsley, Hunter, and Furlong (1992) cited some examples of how computers can be successful in improving students' performance and attitude toward themselves and school. At Lincoln Junior High School in Kenosha, Wisconsin, a project called "Beyond the Limits" is being used. The program involves the use of word processing and graphics software with a 'writing across the curriculum' strategy. The students use clip art, video cameras, and MacVision to digitize images and express themselves in their poetry and writing. At the end of the year, printed copies of their work are used to create a book. At Mid-Peninsula High School in Palo Alto, California, the emphasis is on having students (including at-risk students) use computers in nontraditional ways to make learning more interesting to them. For example, a student in this school hates to write but loves computer games; so a contract was written to solve this dilemma. According to the contract the student agreed to produce a written set of instructions for a game after playing it for a week. Then in 1983 the Higher Order Thinking Skills (HOTS) project began as an effort to develop a better approach to meeting the needs of at-risk students. This approach is supposed to provide students with regular and sustained thinking exercises that are separate from classroom content and take place in social situations. These situations should be motivating and entertaining to the students. The goal of HOTS was to develop a new thinking skills approach that would tap these students' intellectual potential in ways that would increase their thinking ability, their self-confidence, and basic skills. This technique, of replacing supplementary drills with thinking activities, is also effective with other groups of students such as those students who are learning disabled or gifted and talented. The use of computers is an integral part of the program for creating learning dramas or opportunities for conversation or problem-solving activities (Kearsley, Hunter, & Furlong 1992).

Many special education professionals are enthusiastic about the potential of technology to improve the learning opportunities for students with disabilities. Computers can improve communication skills and provide the means to make learning more interesting and rewarding for students (Kearsley, Hunter, & Furlong 1992). Computers are remarkable, versatile tools which lend themselves to supporting the educational process. Research on computers consistently indicates that student attendance, motivation, and attention span increase when computers are used in the classroom (Moore, & Karabenick 1992). When students demonstrate fluctuating motivation, resistance to paper-and-pencil tasks, and limited achievement, it becomes necessary to find multiple ways to involve them. Computers can serve this purpose as a useful tool for creative curriculum modifications. When microcomputers are used effectively, instruction will increase academic learning time, capitalize on student motivation, and lead to academic gains. Motivation increases because many students are eager to accept instruction presented through microcomputer formats. Attention is increased through the addition of animation, sound, color, or other variables used in a manner that focuses attention to the task rather than distracting from it (Day, & Sweitzer 1990).

Computers help students develop a sense of self-control, inner power, and autonomy because they have the opportunity to interact immediately and explore creatively (Wepner, 1989). In a study on the impact of computers on pupil achievement the following benefits were found: computers were found to be good motivators that heightened pupils' interests and enjoyment of subjects; computers aided concentration by focusing pupils' attention; and when students used software to improve the presentation of their work, they showed more pride in their products (Johnson, Cox, & Watson 1994). The authors stated that it is important to notice that these contributions were in terms of higher level processing or thinking. For students with disabilities, some modifications may be needed when they must respond in written form in order to be able to assess their level of performance more accurately. Computers are one modification that may help students with weak fine motor skills get their words or thoughts on paper before they forget them.

Keyboarding Instruction

With the increase in the number of computers available in schools, coupled with advances in software design, a new issue has arisen in schools: keyboarding instruction. Benefits of computers can not be realized if students lack keyboarding skills. Studies have shown that most elementary schools have not included keyboarding instruction in their curriculum (Tenney, & Osguthorpe 1990). Many students spend significant amounts of time using computers and may be developing poor keyboarding habits which will have to be corrected later. Keyboarding instruction has been an important issue ever since the first computer was found in public schools. Students need to know proper hand placement and where keys are located so they can move away from the hunt-and-peck method of typing to a more fluent system.

Research between 1930 and 1970 showed that pupils in elementary schools can be taught touch keyboarding. Bortholome and Erickson found that when children developed keyboarding skills, they improved their performance in other subjects (Tenney, & Osguthorpe, 1990). Evidence collected suggests a small positive effect of the use of typewriter/keyboarding on reading, word identification, syntax, and spelling skills and a greater potential effect on writing (Borthwick, 1993). Keyboarding may assist language arts skills by providing a clear visual display of letters, punctuation, and capitalization; developing skills on focusing on a line of print and reading from left to right across a page; and making lower-upper case connections (Borthwick, 1993).

In a study in which five different keyboarding curricula were examined, it was found that instructional programs which allowed students to progress at their own rate were perceived more positively (McClurg, & Kercher 1989). The five different approaches were dividing into the following groups: the video group, Smartype group, Microtype group, Type to Learn group, and the textbook group. Keyboarding training in the video group included a series of videotapes and a six-page student guide. Each half hour lesson used a series of repetitive rhythmic verbal commands and visual cues. The students typed to the beat of a metronome whose speed increased as the lesson progressed. Students used a word processing package while viewing flashing letters on a keyboard matrix from a monitor while typing sequences following a visual and auditory cue.

Students in the Smartype group were asked to name their favorite food, animal, etc. which were incorporated into form sentences used for drill. Smartype is a computer tutorial which uses a letter-by-letter, word-by-word approach. A graphic showing a keyboard and hands remains on the screen at all times. The drill follows the same pattern each time: 1) review of home row keys, 2) illustrations of which finger to use is illustrated twice, 3) students type the letter twice from memory, 4) after the student types the correct letter four times the tutorial moves to the next letter, 5) this procedure is repeated until a word is complete, and 6) after all words have been typed, the entire sentence must be correctly typed before the student can proceed. Once sixteen practice sentences have been typed, a final test is administered to measure accuracy (McClurg, & Kercher 1989).

A more traditional computer keyboarding tutorial was selected for the Microtype group, The Wonderful World of Paws. The two diskettes contain sixteen lessons in which two keys are presented per lesson. Each lesson is presented by Paws (the cat) and follows the same procedure 1) review skills, 2) learn new keys, 3) build speed, and 4) play reinforcement game. Throughout the first three parts, a keyboard is displayed at the top of the screen. Then, at the end of a lesson, a report of the student's typing rate, point total, number of lines repeated, and recommendation of what to do next is provided, with an option for a printout (McClurg, & Kercher 1989).

A language-based computer tutorial was used in the Type to Learn group. Animated hands demonstrated correct stroking of two to three keys per lesson on the keyboard drawn on the computer screen. Twenty-three lessons, a menu of games, speed-up exercises, and scratch pad are provided. However, the student must meet their speed and accuracy goals in order to proceed to the next activity. A textbook approach was used for the last group. Each page in the book had a color-coded diagram of the keyboard, a sidebar of illustrated instructions, and a series of drills. Again, two keys were presented per lesson. According to the results, the textbook group significantly outperformed the Smartype group and the Microtype group but not the Video or Type to Learn groups (McClurg, & Kercher, 1989).

Another study examined the effectiveness of two methods of keyboarding instruction on students with mild disabilities: one in which students use keyboarding software without assistance, and another in which students use the same software but have a tutor to guide them. It was concluded that children with mild disabilities, after nine hours of instruction, can make consistent gains in speed and accuracy in keyboarding skills using either self-directed or tutor-assisted computer-aided instruction (Tenney, & Osguthorpe, 1990). Students can continue to make progress by investing as little as five to ten minutes a day on keyboarding instruction. This evidence supports the assertion that keyboarding should be introduced before it is required for word processing.

In another experiment on keyboarding instruction, a combination of psychomotor and cognitive domains was used. Students in the study wore rings on each finger with an animal picture on each corresponding to a picture on a typewriter key. Then the students memorized rhymes describing each key and the letters they produced. For example "Little Birdies you can see perched on g and a and z" (Borthwick, 1993, p. 8). The experimental study examined over thirty different language arts skills. Overall, the study found gains in the students' language arts skills. Specifically, word identification, syntax, spelling skills, reading, and writing were improved (Borthwick ,1993). It was concluded that keyboarding skills are an important aspect of a child's education and therefore should be included in the elementary education curriculum.

Constant Time Delay

Many studies have researched time delay procedures and generalization, but there is little existing literature on using the computer as a communication device. However, Skinner (1986) emphasized that effective programmed instruction should prime the student for learning by providing correct models that may be imitated and result in accurate responding. Skinner concluded that the "small computer is the ideal hardware for programmed instruction" (Stevens, Blackhurst, & Slaton, 1991).

Time delay is a response prompting procedure in which stimulus control is transferred from a stimulus that controls a response to one that does not control the response (Winterling, 1990). Transfer of control is accomplished by pairing the prompt with the task request until the student can respond without assistance of the prompt.

There are two types of time delay procedures, constant and progressive. In constant time delay, a constant time interval is inserted between the request and the controlling prompt, giving the student time to respond before the prompt if the answer is known or to wait to receive the prompt if the answer is not known. The behavior is considered learned when the student is consistent at making correct responses before the prompt. Constant time delay involves two types of trials, 0-second trials and delay trials. 0-second trials are presented during initial instruction and involve delivering the target stimulus followed by a response prompt. Next delay trials are presented. Delay trials involve inserting a fixed number of seconds between delivery of the target stimulus and the controlling prompt. This teaching procedure has been found effective for students with mild to severe disabilities (Winterling, 1990).

Constant time delay is an effective strategy for small-group instruction with students who have learning and behavioral disabilities (Winterling, 1990). Halle, Baer, and Spradlin (1981) conducted a study which indicated that the time delay technique is quick to teach and simple to implement. It also indicated that time delays provide opportunities for children to initiate their own responses, teachers a chance to generalize their use of delay to novel situations, and teachers can maintain their use of delays over time (Halle, Baer, & Spradlin, 1981). In general, research has shown that constant time delay has been effective in teaching acquisition of a variety of tasks to students with mild disabilities. A potential problem, however, may be keeping the student's attention. One way to ensure that students are paying attention is to require the students to recite a specific statement before performing the desired behavior. This way when the teacher hears the statement they will know the student is on task. This statement could be a mnemonic for the desired behavior.

Mnemonics

A mnemonic is a device, operation, or procedure used to improve memory. Mnemonics have been used for thousands of years to improve memory. The first documented use of mnemonics was among ancient Greeks, who had limited access to writing materials, developed complex mnemonic systems for remembering stories, poems, lectures. and plays (Scruggs, & Mastropieri, 1990). Research has shown that students with learning disabilities and emotional or behavioral disorders who have been taught using mnemonic devices have remembered and retained information at significantly higher levels than those students taught with other methods of instruction (King-Sears, Mercer, & Sindelar, 1992). Mnemonics also greatly improve initial acquisition of sound-symbol relationships, a substantial problem for many students with learning disabilities. Positive experimental effects have been documented for immediate learning and delayed recall intervals of twenty-four hours, two-three days, one week, eight weeks, and ten weeks. In addition, teachers employing mnemonic instruction frequently report that their students stay on task longer, participate more in class, and appear to enjoy learning more when participating in this type of instruction (Scruggs, & Mastropieri, 1990).

Overall, the research is supportive of computer-assisted instruction, constant time delay, and mnemonics. The present study was designed to test the use of computer-assisted instruction, constant time delay, and mnemonics on the keyboarding skills of a student with a mild/moderate mental disability.

Method

Subject

A ten year old student with a mental disability and speech/language impairment served as the subject. He has been diagnosed with Robinow Syndrome and Attention Deficit Hyperactivity Disorder (ADHD). His speech is characterized by multiple misarticulations and significantly reduced intelligibility. The student's difficulty with fine motor execution significantly restricts his academic communication. Due to his fine-motor difficulty, he is still not able to write his own name legibly despite daily practice.

A behavior interventionist from a local school division suggested computer-based training and communication. She believed his poor fine motor control and verbal expression impaired his ability to express learned knowledge. She made this recommendation based on the fact that the subject can use the computer independently, including selecting a disk, turning on the computer, and going through five-seven steps to get a program. As he seems to learn best visually and through modeling, computer-based training can be a helpful tool in addition to the use of mnemonics.

Consent was obtained from the child and his parents prior to the beginning of the research. No information was used that could identify the subject in any way in order to ensure confidentiality. The intervention took place in the child's home on his home computer, an IBM PS1.

Apparatus

An IBM PSI computer keyboard was used to teach keyboarding skills. Six rings with pictures on them were worn on the subject's hands; each picture corresponding to the key the finger should be placed on. Each ring also had a phrase associated with it. These phrases are listed in Table 1. The computer program that was used was Mario Teaches Typing. Slurpees from 7-Eleven, trips to McDonalds, and tractor rides were used as reinforcers. A wrist support was used to help him maintain proper hand position, due to his lack of muscle tone and coordination. The wrist support was placed in front of the keyboard and the subject rested his wrists on it.

Procedure

For this experiment, acquisition of basic keyboarding skills was defined as the subject pressing the appropriate key three consecutive times without a prompt. Constant time delay was conducted by asking the subject to press a key and giving him 0-seconds, 5-seconds, or 10-seconds to recite the mnemonic and press the key. If he did not press the key or pressed an incorrect key, the researcher would press the correct key with the subject's finger and recite the mnemonic.

The researcher obtained baseline data for knowledge of keys by calling a key and observing if the student knew where the key was and which finger to use within 10 seconds. The researcher also obtained baseline data for the student's knowledge of letter sound correspondence by using flashcards. The flashcards contained a diagram of the letters in upper case form. Baseline data collection was followed with sessions for a six-week period, post-test scores for knowledge of keys and letter sound correspondence were obtained. Tests for retention were done periodically. These tests were conducted after the subject learned a new letter.

Each session took approximately 15 minutes, due to the subjects short attention span, or until he met the criterion for the two keys presented in the session. The first step was to have the student place his wrists on the wrist support and his fingers above the home row keys (left hand-asdf, right hand-jkl;). Then the researcher recited a mnemonic and immediately pressed the key with the students correct finger and had him repeat the mnemonic. The researcher alternated between two keys of corresponding fingers (i.e. f and j). With the second presentation of the key and mnemonic, the researcher stated the mnemonic and waited five seconds before giving a prompt (pressing the appropriate key with the subject's finger) if the subject did not press the key on his own. Once the subject had been given three 5-second trials and had not met the criterion of correctly pressing the correct key three times consecutively then 10-second trials were administered. The 10-second trials were repeated until the subject met the criterion, given prompts as needed. Once the subject had met the criterion for a letter, a new letter was presented. After each new letter with which the subject met criterion, a test of retention was given. The test of retention was stating a mnemonic in random order and observing if the subject still remembered where the key is located. This procedure was repeated until all the home row keys had reached criterion level, or until the six week time period was up. After the subject met criterion (pressing the correct key three consecutive times) or the fifteen minute time frame was up, a computer tutorial was used to reinforce the typing skills. The tutorial, Mario Teaches Typing, involved the student helping Mario race past a series of boxes and turtles blocking his path. Each turtle or box was labeled with a letter. To help Mario, the student must correctly type the letter on the box or turtle. Once the student hit the correct key, the box exploded or the turtle flipped over on its back, and Mario got to go forward to the next box or turtle. The title of the level used was, Mario's Smash and Dash. There are also other levels on the program, but for this experiment just Mario's Smash and Dash was used. Also the program was set up so just home row keys would be on the boxes. The computer also provided the researcher with the number of keys typed, the number of errors, words per minute, goal word per minute, accuracy, and problem keys after each session.

Errors were defined as the subject pressing the wrong key after receiving the mnemonic. When this happened, the researcher said "Good try but that's incorrect," and then pressed the appropriate key with the subject's finger. During the computer tutorial if he pressed the wrong key the researcher would read the letter on the block or turtle aloud until he pressed the appropriate key.

Results

Letter/Sound Correspondence

Baseline data for letter sound correspondence are presented in Figure 1. Before the intervention, the subject could make the appropriate sound for one of the eight letters presented on flashcards. After the intervention, the subject could make the appropriate sound for six of the eight letters presented on flashcards. Data for letter/sound correspondence can be found on Table 1. Thus it can be concluded, mnemonics are an effective strategy for teaching letter/sound correspondence.

Typing

Baseline data for typing are shown in Figure 1. The subject knew where three home row keys were located before treatment and eight after intervention. The number of trials required to acquire each key is presented in Table 3. It took four trials for each key except for D (5 trials), K (8 trials), and the subject never met criterion for A and Semi-colon in the six-week period. The subject used the correct fingering for only the F and J keys. He frequently used the appropriate fingering for the D and K keys. He was unable to use the correct fingers for the A, S, L, and Semi-colon keys. It can be concluded, the subject learned the home row keys' locations.

Retention Tests

The retention tests for letter/sound correspondence were done after each new key for which the subject met criterion. The subject remembered the correct sounds for six out of the eight keys on which he was re-tested. The subject was unable to make the appropriate sound for the letters F and J.

The subject performed with one hundred percent accuracy on all the retention tests for typing. These retention tests, for basic typing skills, were done after each new key for which the subject met criterion. He remembered where all the keys were located when asked to find them in random order.

Computer Tutorial

The computer tutorial, Mario Teaches Typing, provided the researcher with the number of keys typed, errors, and percent accuracy after each session. As would be expected, Figure 2 demonstrates, that as the number of keys typed went up so did the number of errors. This correlation was found to be significant, $r = .99$; $p \leq .05$. Although speed and accuracy were not a specific area of investigation in this study, the results suggest that the subject performed as would be expected. This is because the faster he typed the more errors he made. Figure 4 demonstrates that as the accuracy went up the speed in seconds went down. This correlation was found to be significant, $r = -.69$; $p \leq .05$.

Discussion

It was determined that mnemonics are an effective strategy for teaching letter/sound correspondence. However, due to a ceiling effect, the researcher is unable to determine, if the constant time delay procedure was effective in teaching typing skills. Conclusions on the effectiveness of the computer tutorial can not be determined due to programming problems.

.Letter/Sound Correspondence

As stated earlier the subject learned the majority of the sounds for the letter presented (home row keys). The subject learned all the letters except for F and J. This may be a result of his speech impairment and the fact that he was born with a cleft pallet (which has been surgically corrected) and has overcrowding of the teeth and jaw. He also had trouble repeating the mnemonic for these two keys. Further work on the subject's speech is needed.

Typing

Visual inspection of the data indicates that the subject learned the location and sound of the keys. However, the computer data are not consistent with the baseline data. This can be explained by a fault with the computer tutorial chosen, and by the subject's mental and physical difficulties. The data seen in Figures 2 & 3 are scattered; there is no linear increase or decrease in behavior. It is to be expected that a child with Attention Deficit Hyperactivity Disorder would not be consistent from day to day. A child with such a disorder is easily distracted, and during the six-week period of intervention there were many distractions. The distractions included: his birthday, his brother's birthday, snow, no school due to snow, and episodic seizures. During these episodic seizures, it was impossible to maintain control, communication, and attention. These seizures are similar to other seizures in looks, at first, but then he becomes physically and verbally aggressive. This happened twice during the intervention. On these days (2/7 and 2/9) he typed more keys, made more errors, and typed faster, thus resulting in lower accuracy than days on which he did not have a seizure. On days he did no go to school because of snow the same thing occurred with his typing.

According to the computer, the average number of keys he typed (in two minutes) was 144, the average number of errors he made was 117, his average accuracy was 20%, with an average speed of 1.20 keys/second. These numbers are misleading. Due to a problem with computer program itself (of which the researcher had no control) and the physical difficulties of the subject the number of keys typed and the number of errors are way above the actual count. The researcher keep a tally of the number of errors she saw and a tally of the number of keys the computer counted each time the subject pressed a key. The latter was done because the subject had a tendency to hold a key down too long and the computer would count it as pressing it more than once. In fact, the computer counted each key pressed an average of sixteen times instead of one time. This explains why the researcher found an average of seven errors per session compared to 117 recorded by the program (See Figure 5). The researcher tried to get in touch with the company who made the program but was unable to do so. Another limitation with the computer tutorial was that the program presented all ten home row keys at the beginning of the intervention when the subject had only been presented two of the keys.

As Table 2 shows, the number of trials the subject required to reach criterion for each key was four trials, except for D (5 trials) and K (8 trials). These data suggest that the procedure was efficient, on the average requiring 15 minutes to learn two keys. Thus, we may predict that in approximately 32.5 instructional hours the student could be expected to learn all 26 letter on the keyboard, despite possible attentional deficits. Considering the importance of the acquisition of keyboarding skills, discussed in the literature review, such an expenditure of instructional time seems appropriate.

Constant Time Delay

Since the subject was able to reach criterion for most of the keys without a prompt, a ceiling effect was obtained. The subject learned the key's location without the researcher having to prompt him. Thus, the effectiveness of this procedure can not be established. Perhaps, the task was too simple for the procedure or the time delays between the request and the prompt were too long. However, the subject may have made more errors if more keys were introduced. Only further studies can determine if this procedure is effective.

Conclusion

The results of this study support the effectiveness of mnemonics in teaching letter/sound correspondence to a child with Robinow Syndrome and Attention Deficit Hyperactivity Disorder. Due to the previously mentioned problems with the computer tutorial and the ceiling effect obtained, the effectiveness of the computer-assisted instruction and constant time delay procedures can not be established

Further, the intervention process reported here represented a collaborative effort between the researcher, subject, subject's teacher, and the subject's parents. The hypothesis for this study was developed conjointly, and the experimental interventions were implemented by the researcher in the subject's home. Because of the joint effort, the intervention was one that was both feasible and practical. We believe that such an effort is critical for developing interventions in which the subject is willing to participate and the researcher willing to implement. This experiment added important elements to the idea of individualization of curriculum for students with special needs. It showed that increased individualization of curriculum leads to student gains and would significantly contribute to the general goals of public education. Specifically, skills that are necessary to survive and contribute to the global society later in life should not be neglected. Basic typing skills are becoming more and more necessary as the world becomes more and more integrated with computers.

Finally, because only one subject participated in this study, the generalization of the findings is limited. Further research will be required to demonstrate the efficacy of computer assisted instruction, constant time delay, and mnemonics in teaching basic keyboarding skills with students who share the subjects characteristics. It will also be useful to replicate the various components that were a part of this study individually to see which parts were actually effective. Also further research is necessary to evaluate the effectiveness and efficacy of the computer program itself as well as the constant time delay procedure. Follow-up studies should be done to observe if the subject maintained the information presented over time. A future study on other keys on the keyboard may also be warranted.

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Appendix A

Consent Form

Longwood College
Consent Form

I, consent to participate in the research project entitled: Acquisition of Keyboarding Skills: A Single Subject Design. I acknowledge that the purpose of this study, the procedure to be followed, and the expected duration of my participation have been explained to me. I understand that my participation in this research is voluntary, and I am free to withdraw my consent at any time and to discontinue participation in this project without prejudice.

I acknowledge that I have had the opportunity to obtain additional information regarding this research project, and that any questions I have raised have been answered to my full satisfaction. I understand that no information will be presented which will identify me as the subject of this study unless I give my permission in writing.

I understand that if I have concerns about my treatment in this study, I am encouraged to contact the Office of Academic Affairs at Longwood College at (804) 395-2010. I acknowledge that I have read and fully understand this consent form. I sign it freely and voluntarily.

Date: ____________________ Signed: ________________________
(Student)

Date:____________________ Signed: _________________________
(Parent)

Date:____________________ Signed: _________________________
(Parent)

Tables

Table 1
Mnemonics

A	Angry Ape
S	Silly Serpent
D	Dancing Donkey
F	Fancy Fox
G	Giant Giraffe
H	Happy Hippo
J	Jolly Jaguar
K	Kind Kangaroo
L	Lovely Lion
;	Eeky Sleeky Snake

Note. The red indicates Letter/ Sound Correspondence was taught.

TABLE 2
Letter/Sound Correspondence

Target Letter	Baseline Before	After
D	No	Yes
F	No	No
J	No	No
K	No	Yes
L	No	Yes
S	Yes	Yes
G	No	Yes
H	No	Yes

Table 3
Keys Typed

Target Key	Baseline Before	Baseline After	# of Trials
A	No	No	--
S	Yes	Yes	4
D	No	Yes	5
F	No	Yes	4
G	No	Yes	4
H	No	Yes	4
J	No	Yes	4
K	Yes	Yes	8
L	Yes	Yes	4
;	No	No	--

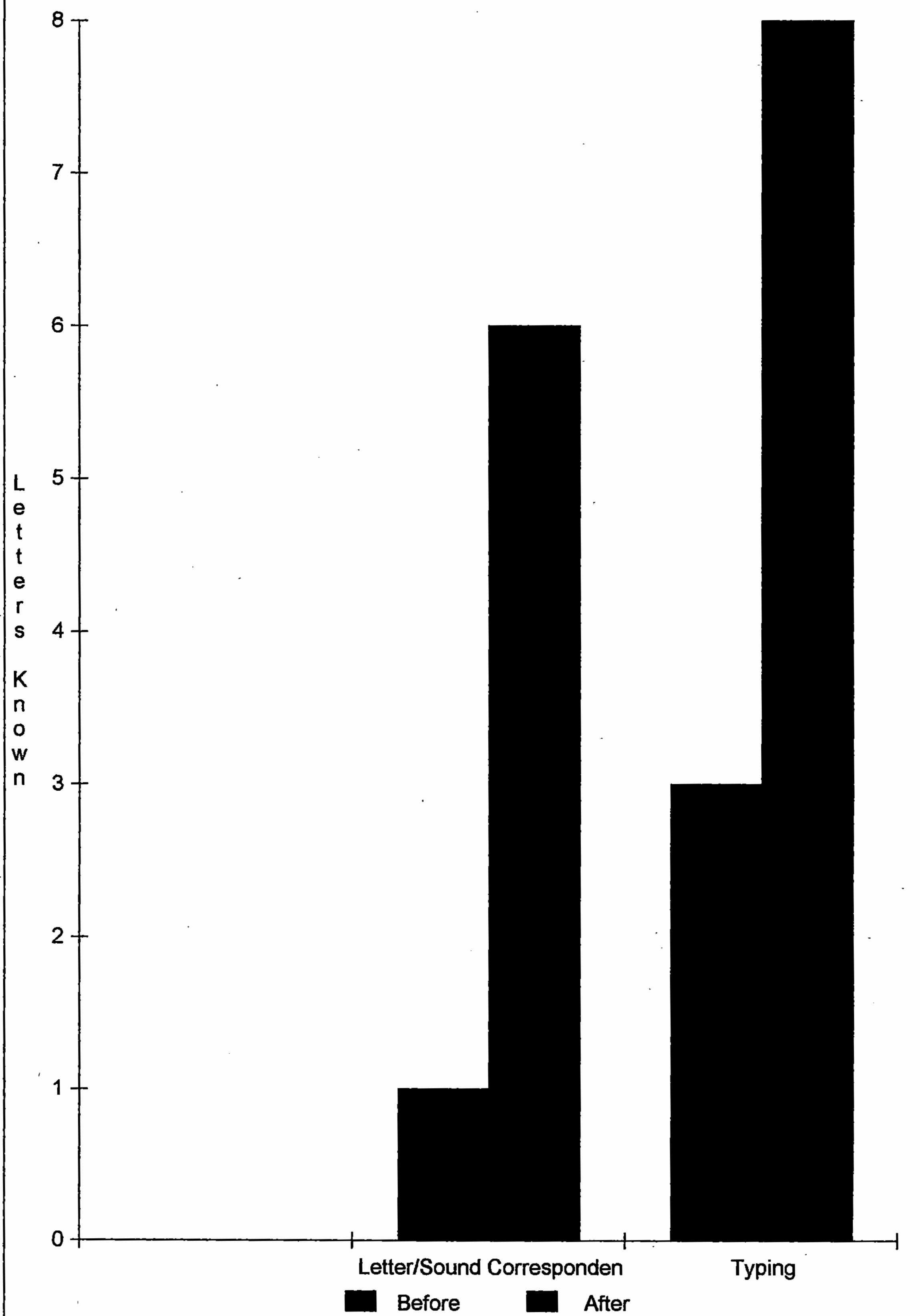
Table 4
Correlations

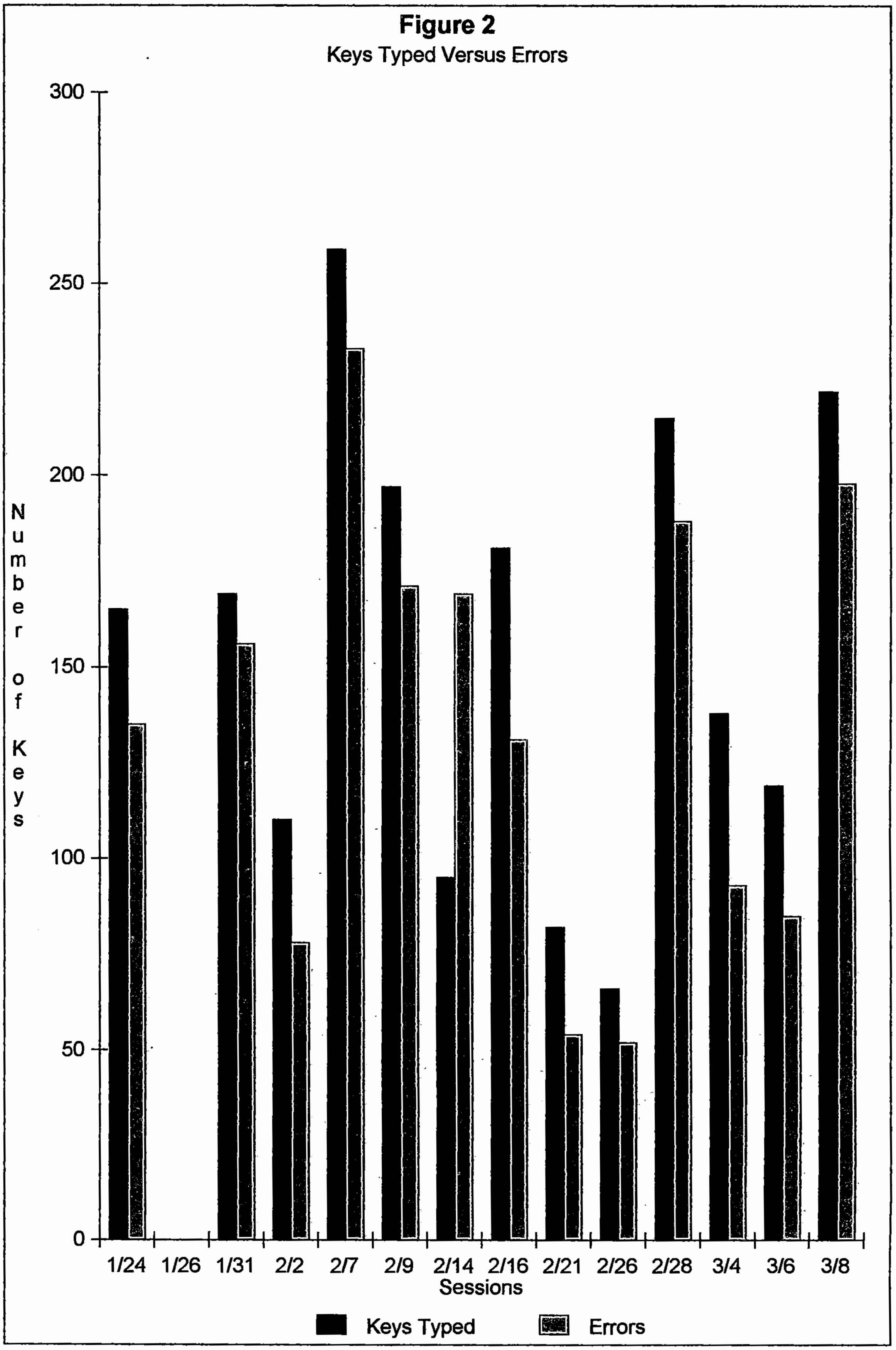
Source	Critical Value	Coefficient	Significance
Keys typed and Errors	.57	.99	$p \leq .05$
Speed and Accuracy	.57	-.69	$p \leq .05$

Figures

Figure 1

Baseline Data

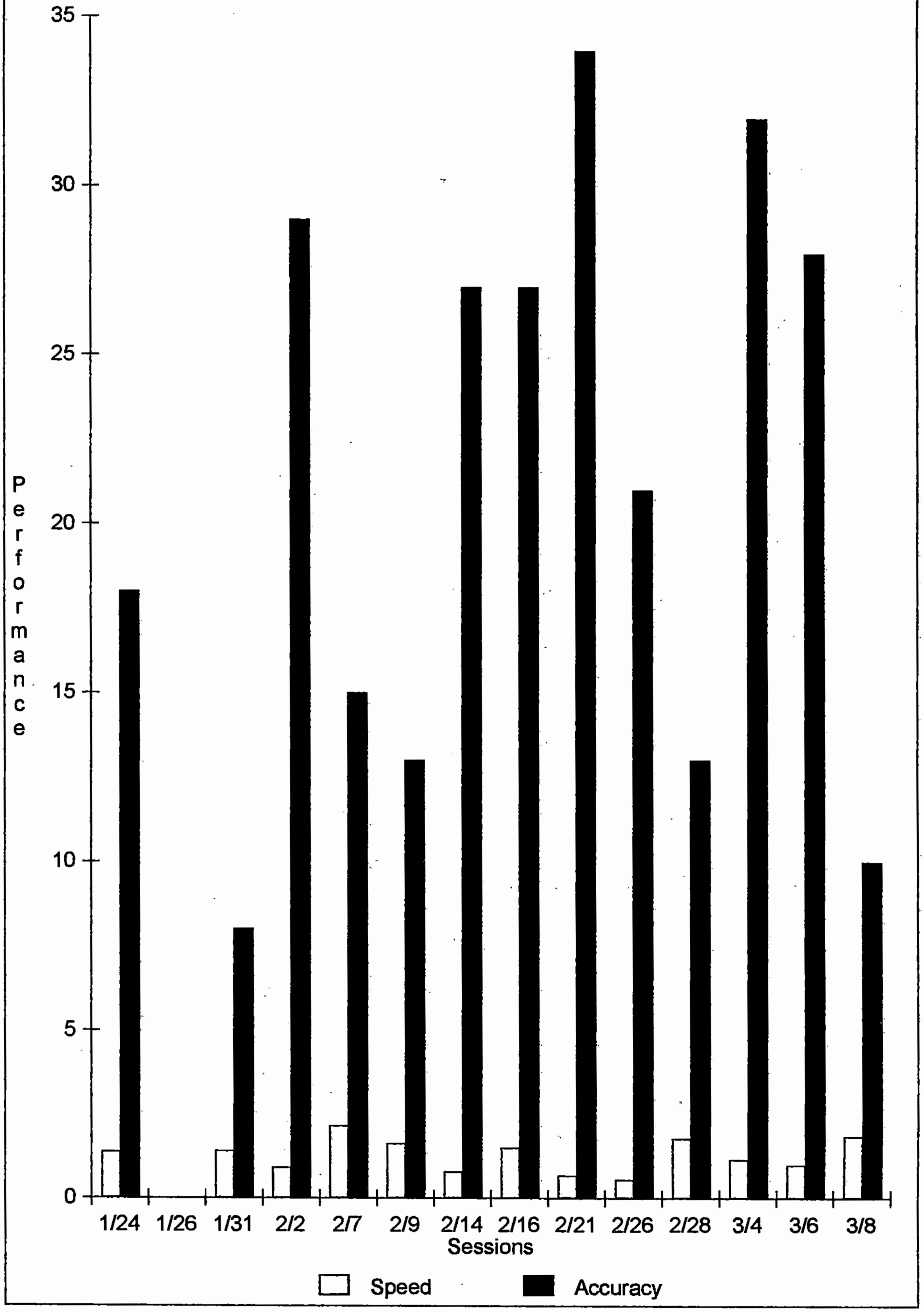




Note. Zeros on 1/26 were due to the subject cutting the computer off before data was obtained.

Figure 3

Speed Versus Accuracy



Note. Zeros on 1/26 were due to the subject cutting the computer off before data was obtained.

Figure 4

Inconsistencies