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ABSTRACT

The goal of this 2-year project was to examine applications of microcomputer technology in classrooms for students with severe handicaps. Staff members in 12 classrooms in the School District of Philadelphia (Pennsylvania) were taught to use Apple IIe microcomputer systems and various peripheral devices. Teachers in these classrooms found word processing software helpful in assisting home-school communication, but data management applications were not viewed as time efficient. In the area of student instruction, the computer was useful as a means for developing motor skills and learning response/reinforcement contingency relationships. The physical arrangement of the equipment and the match between student and input device emerged as important considerations in promoting successful student-computer interaction. Only a small proportion of students in project classrooms were able to use software intended to teach basic concepts and language skills. In addition to summaries of project activities and outcomes, this report contains the following appendices: (1) a paper titled "The Use of Technology in Educational Programs for Students with Multiple Handicaps" by Gail McGregor; (2) abstracts of other papers; and (3) a manual titled "Introduction to the Apple" which discusses peripheral devices, computer applications in special education, and activities for instruction and management. (JDD)

Final Report

Applications of Technology in the Education of Severely and Profoundly Impaired Students: Research, Training, and Dissemination

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Abstract

The goal of this two year project was to examine applications of microcomputer technology in classrooms for students with severe handicaps. Staff members in twelve classrooms in the School District of Philadelphia were taught to use Apple IIe microcomputer systems and various peripheral devices. These classes served as sites in which computer-assisted instruction and management activities were evaluated. The results indicated that teachers found the computer helpful in assisting them with home-school communication. Data management applications using currently available software were not viewed as time efficient. In the area of student instruction, the computer was useful as a means for developing motor skills and learning response/reinforcement contingency relationships. The physical arrangement of the equipment and the match between student and input device emerged as important considerations in promoting successful student-computer interaction. Only a small proportion of students in project classrooms were able to use software intended to teach basic concepts and language skills. The scanning format of this softwear presented a barrier to students.

Project staff members and participating classrooms also served as technology training resources for other special education personnel in the School District. Numerous presentations at national conferences and inservice training workshops served as vehicles for disseminating information regarding microcomputer applications with students with severe handicaps on a national basis.

Introduction

This report summarizes of research, training, and dissemination activities conducted during the period October 1, 1984 through September 30, 1986. In order to serve as both an accountability document and as a means of disseminating findings to the special education community, the following format has been used. The main body of this report is organized around the four project goals: computer use for classroom management, computer use for student instruction, staff training, and dissemination. Within each of these areas, a summary of activities and outcomes is presented. The results of individual research studies, training materials, and papers which more thoroughly examine issues related to these topics are referenced in the narrative and included as appendices. Appended materials are stand-alone documents which are likely to be of greater interest to the special education community than the main body of this report.

Project Overview

This two year project was a collaborative effort between the Division of Education, School of Continuing Studies, Johns Hopkins University, and the Division of Special Education of the School District of Philadelphia. Its purpose was to investigate applications of microcomputers in classrooms for students with severe handicaps. Each of twelve classrooms serving students with severe handicaps was equipped with an Apple IIe microcomputer, color monitor, dual disk drives, printer, and an interface device which enabled students to access the computer with a single switch. The classrooms were selected to equally represent students at the elementary, junior high, and high school levels. A description of the project participants is contained in Table 1.

Insert Table 1 about here

The project was implemented in phases corresponding to the two project years. During Phase I, staff training and project activities involved six classrooms. The remaining six classrooms were involved in project activities during year two.

The project activities were organized in terms of five primary goals:

1. To investigate applications of microcomputer technology for classroom administration, data collection, and data utilization purposes.
2. To investigate the benefits of microcomputer technology in the instruction of students with severe handicaps.
3. To train special education personnel in the use of technology in the education of students with severe handicaps.
4. To disseminate information about project activities to interested professionals.

Table 1

Description of Project Participants

School/Teacher	Level	Number of Students	Age Range
		PHASE I	
Ethel Allen (Wurzel)	Elementary	8	6-8
George Washington (Di Paoli)	Elementary	5	5-9
Wanamaker (Harshbarger)	Jr. High	7	12-15
Germantown (Tunney)	High School	7	17-20
Simon Gratz (Hagarty)	High School	8 27	17-20
University City	High School	6	17-20
		PHASE II	
Leidy (Sachs)	Elementary	7	6-10
Farrell (Bauer)	Elementary	5	8-11
Wanamaker (McCue)	Jr. High	5	12-15
Harding (Boyce)	Jr. High	7	12-15
Frankford (Roth)	High School	24 8	17-20
West Philadelphia (Horwitz)	High School	7	17-20

Specific activities, accomplishments, conclusions and recommendations in relation to these four goals are described in the following section.

Classroom Management

Teachers in classrooms for students with severe handicaps in the School District of Philadelphia have clearly delineated obligations and procedures related to classroom management activities. Specifically, they must communicate with the parents of their students at least once per week, and they must collect performance data in relation to each of their students' IEP objectives at least one per week. These data are then used to make instructional decisions regarding student progress. These tasks are time consuming, and lend themselves to computerization. Therefore, the use of word processing and data management software by project teachers were identified as appropriate project activities.

Computer use data. In order to monitor the extent to which teachers used the computer for management and instructional activities, a small wooden box with two time lapse counters and two on/off switches was added to the standard classroom computer configuration (see Figure 1).

Insert Figure 1 about here

The power cord of the computer was plugged into this box so that the computer could be turned on only by using one of the two switches. One counter was labeled "classroom management" while the other was labeled "student instruction." Teachers were instructed to turn the computer on using the switch which described the nature of the activity they were

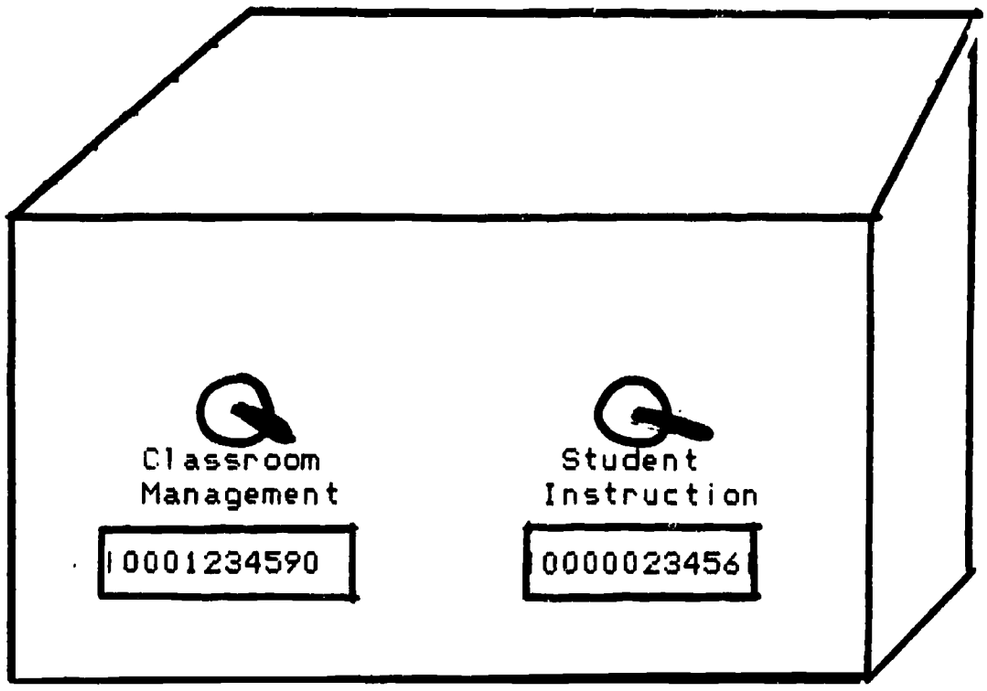


Figure 1. Device to monitor computer use for management and instruction.

starting. If, for example, they were preparing to write a note home to a student's parent, they would use the Classroom Management switch to turn the machine on. This, in turn, would activate the time lapse counter, maintaining a cumulative record of the amount of time the computer was used for management activities. Similarly, computer time devoted to student instruction was tallied by activating the Student Instruction switch at the appropriate times.

The data describing computer use for a sample of six classrooms during the second project year are summarized in Table 2. This sample equally represents Phase I and Phase II classrooms.

Insert Table 2 about here

It should be noted that the information registered on the recording devices may not accurately represent the total amount of time that each computer was used for instructional and management purposes. The integrity of the instrument readings is governed by the teachers use of the system. If the teacher disconnected the computer from the recording device, or activated the wrong switch, then the elapsed time readings on the box would not represent the true use of the computer in the classroom.

Looking at the existing data it becomes apparent that the proportion of computer use time for instructional and management purposes is idiosyncratic to the individual teacher. In two of the six classrooms, instructional use of the computer predominated, and management uses of the computer exceeded instructional uses in two other classrooms. The

Table 2

Analysis of Computer Use Time, Year II

Phase	School	# of Days	Instructional Activities*	Management Activities*
I	Gratz	129	10.4	14.3
I	Wanamaker	120	9.9	26.7
I	Washington	118	54.4	5.9
II	Farrell	126	66.1	24.3
II	Harding	111	27 3	36.9
II	Wanamaker	115	19.1	77.5

*Data presented in hours

remaining two teachers used the computer almost equally for the two purposes studied.

Word processing. As described in greater detail in the staff training section of this report, the teachers were provided with the AppleWorks software to assist them with home-school communication. This is an integrated software package with word processing, data base, and spread sheet capabilities. Classroom utilization emphasized the word processing function of this program. In order to assess the extent to which teachers chose to use the computer over pen and paper to write their messages, the teachers were asked to save computer-generated messages on a data disk. Non-computer messages were written in a notebook of two-part carbonless paper, producing copies of the messages which could be counted and analyzed by project staff. Data regarding the number of messages written in each format is available for four project classrooms. As indicated in Table 3, three out of four teachers used the computer to generate written messages more than half of the time.

Insert Table 3 about here

The messages sent by teachers were further categorized according to their purpose. Messages served to notify parents of special events, comment about their student, report a behavior problem, request materials, or suggest that a meeting be held. Miscellaneous content was classified in the "other" category. The data in Table 4 suggests that computers were used most frequently to notify parents of special events. These noticed

Table 3

Patterns of Home-School Communication

School	Number of Weeks	Total Written Messages	Means of Production (%)	
			Computer	Pen & Paper
Washington	28	91	22	78
Farrell	27	105	65	35
Leidy	29	259	53	47
Gratz	30	271	66	34

were generally non-personal in nature, and were sent to the parents of all students in the class. It is not surprising that the computer was used in this situation, given the ease of producing multiple copies of a document. Miscellaneous messages comprised the second most frequent type of communication produced by the computer. Teacher comments indicated that, for short personalized notes, it was easier to use paper and pen than it was to load the word processing program.

Insert Table 4 about here

One additional consideration must be mentioned in viewing these results. As with any new skill, a developmental process was evident in regard to the teachers' word processing proficiency. Until the basic commands and procedures of a word processing program have been mastered, it is likely that more time will be required to produce a document with a computer than with pen and paper. Probe data for four classrooms, consisting of all home-school written communications within three 3-week periods, at the beginning, middle, and end of project year two, are presented in Figure 2.

Insert Figure 2 about here

These data clearly indicate that, at the beginning of the school year, computer generated messages to the home were less frequently used then were non-computer generated messages. By mid-year, three of the four classrooms

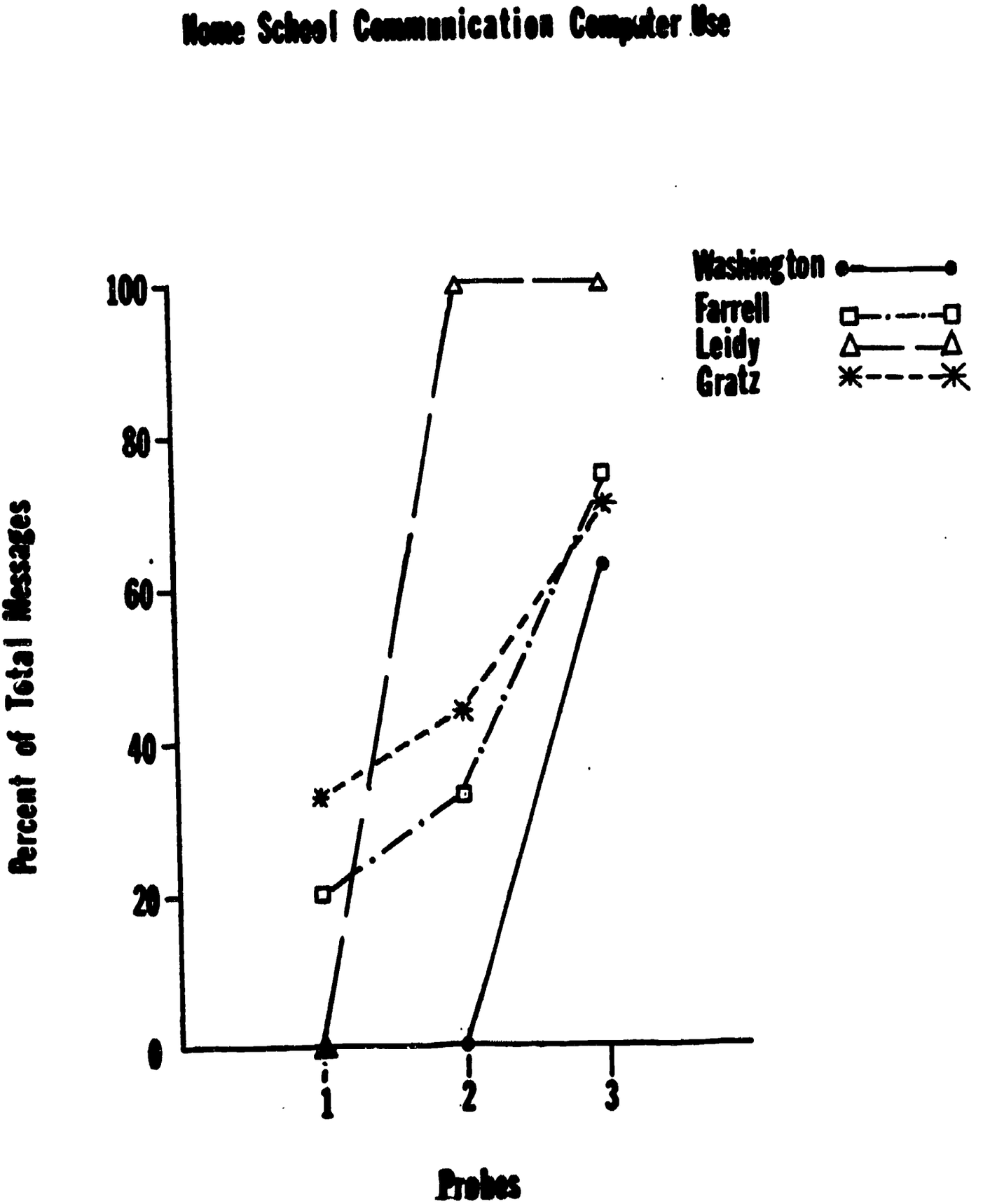
Table 4

Analysis of Computer Use in Home-School Communication*

Purpose of Message	Total	Means of Production (%)	
		Computer	Non-Computer
Notice of events	428	74%	26%
Medical emergency	8	25%	75%
Comments about student	131	15%	85%
Report behavior problem	3	0	100%
Requests for materials or conferences	69	23%	77%
Other	86	55%	45%
TOTAL:	726		

*Data based on sample of four project classrooms.

Figure 2



Probe #1 conducted from 11/11/85 to 11/29/85

Probe #2 conducted from 1/27/86 to 2/14/86

Probe #3 conducted from 3/31/86 to 4/18/86

had increased their use of computer generated messages. The final probe, taken during the spring, indicated that the computer had become the most frequently used medium for written communication with the home in all four classrooms.

Managing student performance. When this project was initiated in 1984, the AIMSTAR program (Hasselbring & Hamlett, 1983) was only data management package available that was designed to store and graph student performance data. The program also provides the user with the option of analyzing a student's data file in relation to a set of decision rules based on the principles of precision teaching. If this option is selected, the teacher is provided with feedback regarding the student's progress in an instructional program. After analyzing a student's data, for example, a message might be generated which tells the teacher that there are "too many days without progress - revise instructional program."

All teachers were exposed to the AIMSTAR program during the initial teacher training conducted at the beginning of each phase of the project. Since the purpose of using this program was to make data collection more time efficient, it was a major concern that every teacher in the group was reluctant to use the program, suggesting that it would increase the time required to record and analyze student performance data. As illustrated in Figure 3, the teachers were using a pencil and paper method of data

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Insert Figure 3 about here

CUE AND RESPONSE CODES:
+ = Independent
IV = Indirect Verbal
DV = Direct Verbal
G = Gestural
B = Behavioral Model
P = Physical
- = No Response

10-STEP TOTAL TASK RECORDING AND CHARTING FORM

Urban Model Project

Student _____ IEP Objective Eating with a Spoon

Criterion _____ Date Start ____ Date Attained ____

Strategy/Reinforcement _____

DATE:													
STAFF:													
SETTING:													
TASK ANALYSIS	%	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE	%
1. Responds cue w/in 10 seconds	100	0	0	0	0	0	0	0	0	0	0	0	100
2. Grasp spoon appropriately	90	0	0	0	0	0	0	0	0	0	0	0	90
3. Brings spoon to plate	80	0	0	0	0	0	0	0	0	0	0	0	80
4. Scoops food onto spoon	70	0	0	0	0	0	0	0	0	0	0	0	70
5. Brings spoon to mouth	60	0	0	0	0	0	0	0	0	0	0	0	60
6. Places spoon in mouth	50	0	0	0	0	0	0	0	0	0	0	0	50
7. Uses lips to remove food from spoon	40	0	0	0	0	0	0	0	0	0	0	0	40
8. Returns spoon to plate appropriately	30	0	0	0	0	0	0	0	0	0	0	0	30
9. Scoops food onto spoon	20	0	0	0	0	0	0	0	0	0	0	0	20
10. Repeats steps 5-9	10	0	0	0	0	0	0	0	0	0	0	0	10
	0	0	0	0	0	0	0	0	0	0	0	0	
GRAPH CODE: ○													
Corr. Resp:													
No. of Steps:													
% Correct:													
GRAPH CODE: ●													
No. of ____:													
No. of Steps:													
% of ____:													
SUBANALYSIS OF STEP NO.													
1.	100	0	0	0	0	0	0	0	0	0	0	0	100
2.	80	0	0	0	0	0	0	0	0	0	0	0	80
3.	60	0	0	0	0	0	0	0	0	0	0	0	60
4.	40	0	0	0	0	0	0	0	0	0	0	0	40
5.	20	0	0	0	0	0	0	0	0	0	0	0	20
	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAPH CODE: ■													
Corr. Resp:													
No. of Steps:													
% Correct:													

Figure 3. School District self-graphing ~~data sheet~~.

collection in which self-graphing sheets enabled them to plot and visually inspect data in one step. In order to use the AIMSTAR system, the teachers were required to transfer information from their data sheets and enter it into the computer. From their perspective, the "cost" associated with having to transfer data each day for up to eight students clearly outweighed the benefits of having the data stored on disk and available for reports and further analysis. For this reason, further evaluation of the AIMSTAR software was limited to a small sample of teachers and for a limited period of time.

Three teachers providing instruction during summer school used AIMSTAR for two programs for one of their students. After being taught to use the program, each teacher required additional assistance in order to set up their student files and to enter program descriptions. They also were supervised during the data entry process for the first several days. All project teachers were asked to respond to several questions regarding the usefulness of the computer for performing classroom management tasks. The responses from the three teachers who had more direct experience using AIMSTAR are differentiated from the rest of the sample in the data summary presented in Table 5.

Insert Table 5 about here

Software-based data collection. An increasing number of software programs have the capacity to collect student performance data. These programs provide meaningful performance summaries which can aid the teacher

Table 5

Teacher Perception of Computer Use for Classroom Management Tasks

Classroom Management Task	Rating*	
	Sub-Sample	Total Sample
Records management	1.0	1.8
Preparing letters and reports	4.0	3.55
Collecting student performance data	1.66	1.55
Analyzing student progress	1.66	1.45

*Rating is based on following scale:

0 = Not useful at all
2 = Somewhat useful
4 = Very useful

in making instructional decisions. For example, the Multisensory Authoring Computer System (MACS) has a data-capturing feature which permits teachers to review performance data on the screen or onhard copy. Precise information relative to the students' selection on each trial can be reviewed for error analyses. Also the performance record includes information pertaining to difficulty level, type of cues, and feedback and reinforcement in the current lesson.

Collectively, these data sources obviate the need for extensive record keeping, thus relieving the teacher of a time-consuming, non-instructional task. A more complete treatment of the use of the microcomputer for data collection purposes in classrooms is provided in a paper abstracted in Appendix A.

Conclusions and recommendations. Teachers are faced with many competing demands for their time during the school day. When the acquistion and integration of new skills and materials must compete with ongoing concerns, change is likely to be gradual rather than dramatic in nature. Teachers inexperienced in using computers to perform classroom management tasks must invest a considerable amount of time in order to realize the time-savings afforded by this technology. In the performance of classroom management tasks, it is clear that the benefits of using a computer are more readily available to teachers in the preparation of written materials than in the recording and analysis of student performance data. Within the time frame of this project, a majority of the teachers became proficient in preparing written material using a word processing program, and reported that they found this to be a useful resource. There

is reason to believe that, with software programs better matched to the needs of teachers, and with additional time to learn their use, data management applications would be used and more highly valued in these classrooms.

Instructional Applications

A discussion of the instructional areas in which microcomputers can be used with students with severe handicaps is contained in a paper in Appendix B. The reader is referred to this paper for a description of microcomputer applications in response-contingent learning, choice making, recreation and leisure, communication, and environmental control. The following section deals with methodological issues arising in project classrooms in regard to the introduction and use of this equipment with students who have severe handicaps. This includes the means by which students interacted with the machine, the general characteristics of the software used in the project classes, instructional strategies, and a discussion of student performance in relation to computer instruction.

Student Access to Computer

The first task facing the teacher of students with severe handicaps in using the computer is to establish an effective interface between student and machine. For most participants in project classrooms, the standard keyboard was not a viable option, although some students were capable of using software which requires non-specific or restricted-range input. Single switch and/or membrane keyboard input devices were effective alternatives to the keyboard. The new Touch Window (Personal Touch Corporation, 1985) is another promising option, but was not available for

use in this project until it was almost over. The input modalities are briefly described.

Non-specific keyboard input. There is a small body of software designed for early childhood education which does not require the student to type in a specific letter or word in order to make a response (e.g., Computations, Inc. - Early Elementary I, II). Rather, the task is presented on the screen in a matching format. In a color matching exercise, for example, two squares appear on the screen. The top square remains constant, while the bottom square changes color every 2-3 seconds. When the color of the two squares matches, the student indicates that they are the same by hitting any key on the keyboard. This stops the presentation and cycles the program into a reinforcement or corrective feedback loop, depending upon the accuracy of the response. Thus, the entire keyboard functions like a switch in this application since a non specific response is all that is required of the student.

Restricted range input. A number of other programs require input which is limited to the space bar and right and left arrow keys. With the use of a partner and/or a keyboard template to restrict access to the remainder of the keyboard, students without motor problems which limit the use of their fingers were capable of using this software.

Single-switch input. For a majority of the students in project classrooms, some type of single switch input was the most effective means for them to interact with the computer. Commercial switches purchased from Prentke Romich and Computability Corporation were supplemented by homemade devices. The substantial savings and greater variety possible when switches are constructed rather than purchased speaks highly for this

alternative. Several guides (Burkhart, 1980, 1982) are available to assist in this process.

The homemade switch types used most frequently in project classrooms are depicted in Figure 4. While the pushbutton and rocker switches approximate switches available commercially, the ribbon switch

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Insert Figure 4 about here

(see Figure 2) provided an alternative which did not have a commercial counterpart. The ribbon switch is made from a flexible rubber switch material available from an electronics store. Eight ounces of pressure will activate this switch. Its variable size and flexibility lends itself to be adhered to the surface of a student's lap tray. Other students who exhibited the natural tendency to directly touch the screen to indicate a response were successful using this switch when it was taped to the bottom of the computer monitor.

Many of the idiosyncratic learning characteristics evident among students with severe handicaps emerged as considerations when attempting to match student to switch. For example, two versions of the pushbutton switch were constructed in response to teacher feedback. The original switch used a pushbutton which created an audible click as it was depressed. This provided feedback that a response had been made that was valuable for some students. For others, this sound was so reinforcing that continually depressing the switch became a stereotypic response which detracted from attention to the screen. A second verson of the switch was constructed which utilized a pushbutton which was inaudible.

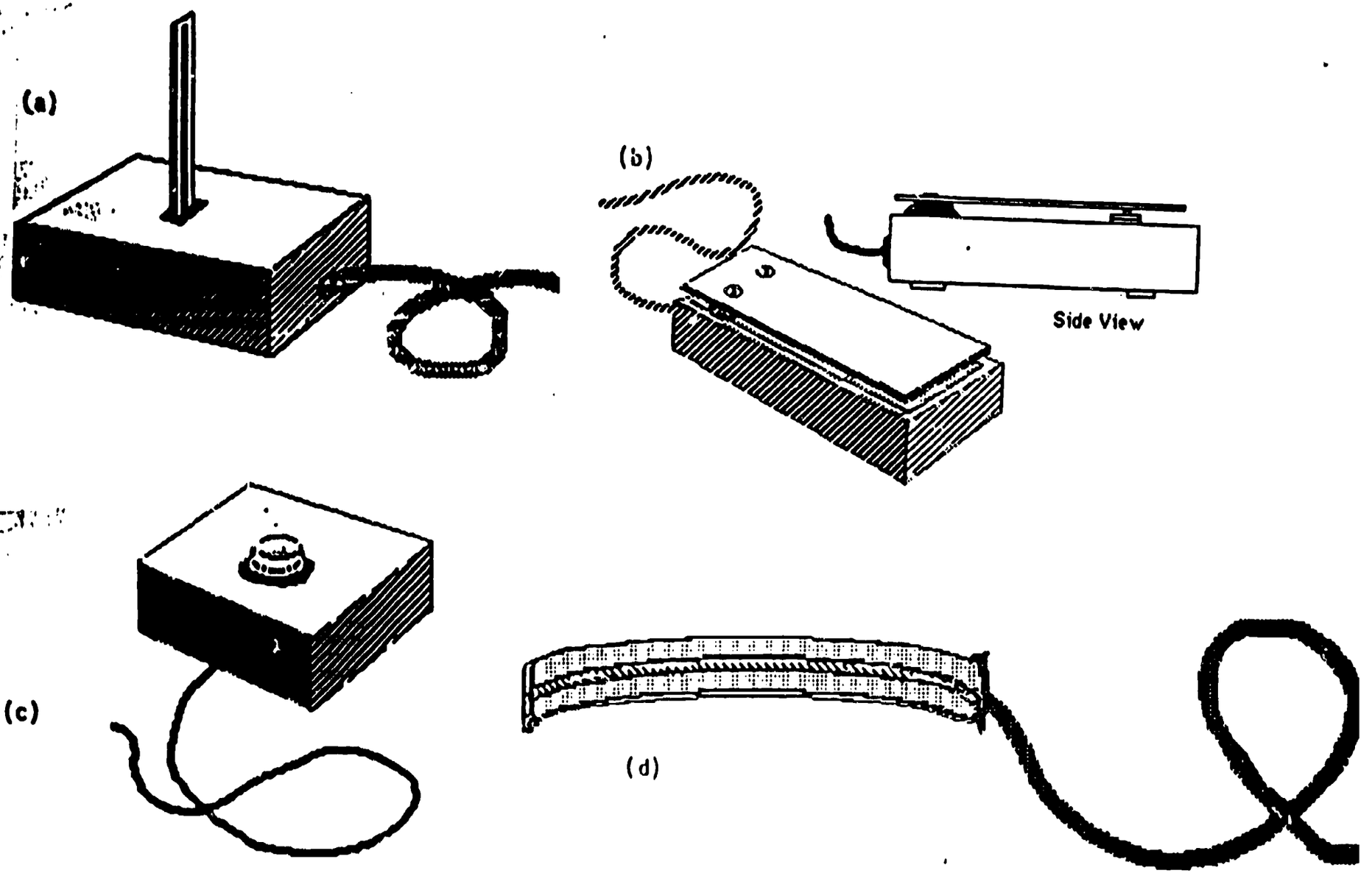

Figure 4. Switches constructed for project classes. (a) flex switch. (b) rocker switch. (c) pushbutton switch. (d) ribbon switch.

Touch sensitive surfaces. A number of different touch sensitive surfaces or membrane keyboards are available for use as input devices. The Power Pad, Koala Pad, and Pres-Fax Board are three examples. However, the limited amount of software which accesses any of these devices as a possible form of input restricts their utility for users who do not have basic programming capabilities. A fourth alternative, the Unicorn Board, is a more viable, but expensive alternative. The Unicorn Board (approximately $300) requires the additional purchase of an Adaptive Firmware Card (approximately $400) in order to be used with the Apple computer. Given this combination, it is possible to customize programs for students with severe handicaps so that they can respond by pressing an area on the touch sensitive surface to enter a response rather than by using the standard keyboard. Finally, the Touch Window is the most recently available alternative to keyboard input. This is a device which can be mounted over the monitor, acting as a touch-sensitive screen. It can also be used horizontally as a graphics tablet or a large switch. While it is less costly than some of the other options (approximately $200), there are few software programs available which are compatible with this input device.

With few exceptions, students in project classrooms were matched with a single switch input device for the purpose of responding to the machine.

Software Characteristics

A list of the software programs used in project classrooms is contained in Table 6. The programs are displayed in the order of frequency with which they were reportedly used by project teachers. For purposes of

discussion and analysis, these programs are described in relation to the content areas they represent. This is followed by an analysis of selected software characteristics in relation to students with severe handicaps, and a list of recommendations for those who design their own programs.

Insert Table 6 about here

Response-contingent learning. In each classroom, teachers introduced the computer to their students with an activity designed to teach them the contingent relationship between operating a single switch and subsequent events on the computer screen. The Motor Training Games disk contains several programs that are designed for this purpose. Selecting either auditory, visual, or a combination of these two forms of stimuli, students learn that hitting the switch will create a new sight/sound. The program entitled Switch Disk provides similar practice with the switch, resulting in a low resolution graphic display as opposed to a screen of solid color. This program has the additional feature of calculating and storing student response latencies. Thus, teachers used this activity as a means of assessing student preference or proficiency with different switch inputs. For students who were able to use the keyboard in a non-specific manner, the Hodge Podge program served a similar function. While intended to reinforce alphabet concepts for young students by associating a picture with the beginning letter of its name (e.g., pressing "B" created the picture of a bear), this program was used by students with severe handicaps to learn that depressing a key on the keyboard will create a visual display that is sometimes accompanied by sound.

Table 6

Software Usage in Project Classrooms

Program	% of Sample	Input Modality	Content Area	Peripherals
Motor Training Games	73	Single switch	Response-contingency Recreation	
MACS	55	Single switch	Receptive language	Voice synthesizer
First Words	45	Single switch Space bar	Receptive language	Voice synthesizer
Talking Writer (Space Invaders)	36	Space bar Arrow keys	Recreation	Voice synthesizer
Switch Disk	36	Single switch	Response-contingency	Voice synthesizer
Scanning Game	18	Single switch	Scanning Recreation	Voice synthesizer
Pickadilly	18	Adapted for use with single switch	Recreation	
Mix & Match	9	Adapted for use with single switch	Recreation	
Hodge Podge	9	Non-specific keyboard	Response-contingency	
Defender	9	Adapted joystick	Recreation	

Recreation/leisure. Several programs on the Motor Training disk incorporate switch activation skills in the context of games. Whereas the tasks described in the previous section are student directed and thus exploratory in nature, these simple games add an element of timing. In the game Frog and Fly, students must hit a switch to catch a fly which is eaten by a frog before the fly crosses the screen. A variation of this task involving boats and airplanes is presented in the game Anti-Aircraft.

Other recreation activities used in project classes incorporated adaptive devices which enabled students to use software designed for regular education students (e.g., Pickadilly, Defender). Creating a customized menu for the Adaptive Firmware Card enabled students to use a switch to select boxes in Pickadilly, a musical concentration-like game. A video game was made accessible to students by rewiring the joystick, and adding a single switch to replace the activating button. When paired with a more capable peer, handicapped students were able to play the game (see related study in Appendix C).

Receptive language. Two computer programs designed to teach receptive language skills were used by a number of students in project classrooms. First Words teaches labeling of objects falling within 10 categories using a type of errorless discrimination format. The student makes a selection by stopping a scanning box around the correct response through depressing a switch. Instructional lessons created with the MACS Authoring System utilize a scanning or stepping selection method for graphic material presented in a match-to-sample format. Students can use either a single

switch or the space bar in order to make a response. Both programs keep a record of student performance which can be printed out for analysis.

Scanning. The software reviewed to this point represents two distinct skill levels. At one end, programs are available for reinforcing switch use which are student rather than task directed. These programs require an awareness that switch activation will cause an occurrence or spectacle on the screen. Other instructional programs which accept single switch input represent a much higher level task, requiring students to respond to stimuli within a scanning box format. There is a sizeable difference in the skills required to use these two types of programs, and many students in project classes were unable to use the latter. The Scanning Game program was used in several classes in an attempt to teach students the visual scanning skills required to use instructional software designed for single switch input. Through the use of animal graphics moving across the screen, students are directed to "catch" the animal by hitting the switch when the animal is in a box. Tracking the animal's movement across the screen requires the same visual behavior involved in following a moving box across the screen. Within a game format, these prerequisite skills can be strengthened.

Analysis of software features. Student observation and the comments of project teachers suggest several software features which were valuable for students in project classrooms.

1. The use of auditory stimuli to reinforce the visual display. Most students responded more readily to displays which had sound effects and/or synthesized speech to direct their attention to the screen.

2. Teacher control of scanning speed. Although most students were unsuccessful in using software which involved a scanning box, the ability to alter the speed of scanning contributed to the success of those students who were able to master this concept.

3. The ability to "freeze" the screen and pace student instruction. Without exception, students required the assistance or supervision of an adult when using the computer. Teachers frequently struggled to provide feedback to students between computer training trials, and the students were forced to continually shift their attention between the teacher and the computer. One program (i.e., Scanning Game) enables teachers to pace the instruction by controlling each trial begins. After the student responds, the screen freezes, providing the teacher an opportunity to provide corrective feedback or reinforcement. When both student and teacher are ready to move on, the teacher indicates that the program should continue by typing in the designated response. In this way, the teacher and computer complement rather than compete with each other.

4. Performance data which reflects assisted responses. While it is highly desirable for a computer to assume the clerical task of recording and storing student performance data, most programs which have this feature recognize a response as being simply correct or incorrect. It is impossible for the computer to differentiate a correct response that is verbally prompted from one that is physically assisted or performed independently. With the exception of testing or probe situations in which the teacher

withdraws all assistance, the dichotomous performance data collected for students in project classrooms were not meaningful. One program (i.e., Scanning Game) used in project classes collected student performance data, enabling teachers to classify each response as independent, verbally prompted, physically prompted, or occurring following a trainer model. The resulting summary of student performance was meaningful, with categories sensitive enough to reflect student change.

Software development recommendations. While it is recognized that the commercial market for the segment of special education students classified as severely handicapped is not large, the following recommendations are made without consideration of these marketing contraints. They represent a "wish list" regarding software for students with severe handicaps formulated after two years of experience with a necessarily small number of programs.

1. Variety in input modalities. Due to the heterogeneous nature of the population of students with severe handicaps, flexibility in regard to the type of input accepted by a program is highly desirable. Most currently available software for this population is configured to accept either a single switch input or an adapted keyboard such as the Muppet Board or Power Pad. Rare exceptions will accommodate a choice of either option (e.g., Choice Maker). To be useful for a wide variety of students, software programs must accommodate all currently available input options, including the newest Touch Window. The inclusion of a set-up routine in the program menu which enables the teacher to save a

particular configuration on the disk provides user flexibility without the need to spend time setting up the program each time it is used.

2. Interactive mode. The teacher's role in computer activities involving students with severe handicaps varies considerably from that which is possible with mildly handicapped or regular education students. Rather than merely overseeing the activity, the teacher frequently continues to be an integral part of the instructional process. This level of teacher involvement creates the need for software which can be used in an interactive fashion by the teacher and student. In other words, the teacher must be able to stop and start instruction at will, specify session length to accomodate different ability levels, specify response latencies, etc. The pacing and freeze frame features of the Scanning Game as well as the start and stop features of the programs on the Omnibox disk are examples of these desirable features.

3. Selectable voice options. The use of a voice synthesizer is a viable alternative for providing instructions, feedback, and reinforcement to non-reading students. In spite of this general utility, there are individual students who are distracted by this stimulus and/or are unable to use the input due to extremely limited receptive language skills. In this situation, corrective messages may not be distinguished from reinforcement, and may be inappropriately acted upon as instructional cues. The option to utilize or eliminate voice input is easily programmable, and enables a teacher to tailor instruction to match individual student learning preferences.

4. User selected content (including graphics). While many authoring systems place significant demands on the user in terms of the time

required to learn and create individual student lessons, mini-authoring systems or "shell" programs present teacher specified content within a relatively fixed format. These programs are typically quickly mastered by a new user. Unfortunately, there are few programs providing this ease and flexibility when the desired instructional stimuli are graphic in nature. Since most students with severe handicaps are unable to respond to text, there is a need to provide teachers with tools that will enable them to design meaningful lessons in a graphic modality without learning to program.

5. Response-related corrective feedback. Most software programs reflect the basic stimulus-response-reinforcement chain of instruction. For students with high rates of correct responding, this format may be adequate. Programs are substantially less powerful in the provision of meaningful feedback when an error is made by the student. A beeping sound or message to "try again" provides no additional information to assist students in rectifying their errors. Students who have no information as to the reason for their errors are forced into inefficient, trial and error responding. Programs should incorporate branching routines that provide instructionally relevant prompts which direct the learner to the correct response.

6. Teacher controlled reinforcement. The contingent use of reinforcement for correct responses can be identified as a strength of computer assisted instruction. During the early stages of learning, this reinforcement schedule may increase correct responding. Nevertheless, there are students and situations for which the dense schedule of

reinforcement characteristic of much instructional software is unnecessary. If teachers could specify the type and duration of reinforcement, thus eliminating time consuming, instructionally unrelated stimuli from a student's lesson, they could begin to maximize the learning which occurs during the time available for the computer. The MACS authoring system, for example, allows teachers to select a reinforcer from a reinforcement menu, and specify the number of correct responses required to obtain it. The option to select from a menu of reinforcers is also present in some commercial, i.e., non-authored, software (e.g., The Math Machine).

Instructional Strategies

The newness of computer use involving students with severe handicaps leaves virtually all questions regarding the most effective instructional strategies unanswered. Although the issues discussed in this section were not subject to controlled research comparisons, decisions regarding these implementation variables were made as a result of ongoing evaluation of instructional effectiveness.

Arrangement of equipment. The physical arrangement of hardware and peripherals can do much to enhance student performance. Through initial trial and error, it became clear that the equipment itself can distract student attention from the computer activity. Most alternative input devices are small and moveable with long cords. Many students find these devices quite interesting in and of themselves, becoming highly engaged in attending to them. Similarly, the keyboard and monitor controls provide an endless source of objects to manipulate. For this reason, the preferred equipment arrangement in project classes was to restrict the student's

access to all system components except the monitor and his/her input device. In those sites where some students were able to use portions of the keyboard, the system was placed in a wooden box designed to hold keyboard templates which exposed only selected portions of the keyboard. All excess cords were secured or hidden to minimize distraction.

Role of teacher. Teachers were an integral part of computer instruction in project classrooms. Given the relative complexity of software design for students with severe handicaps (see previous discussion on scanning), it was necessary to integrate additional instructional support within ongoing computer instruction. The functions of the teachers were to prompt student responses, develop new behaviors through task simplification, and/or consequate student responding.

Response prompting strategies can be described by a "level of assistance" hierarchy typically used with this population for a wide range of instructional tasks. Teachers provide one or more forms of assistance - verbal cues, demonstrations, gesture, or physical guidance - to enable a student to make a correct response. These prompts are provided in either a "most-to-least" or "least-to-most" sequence, depending on the response patterns of a particular student.

Response prompting was also combined with other instructional techniques intended to develop new behaviors. A shaping strategy, for instance, begins with a behavior that a student is currently able to perform and which approximates the target response, and builds upon that behavior until it is the target response. In this case, student activation of a switch independent of the instructional stimuli on the screen was, in most cases, the closest available approximation to using a switch to stop a

scanning box when it surrounds the correct response. A strategy developed for several students based on shaping is outlined in Table 7. The discrimination task in this computer lesson uses a match to sample format.

Insert Table 7 about here

The instructional sequence begins by introducing the switch only when student activation will produce a correct response. Over time, the amount of time the switch is available to the student before s/he must activate it is increased, so that there is a shift in student responding on the basis of the combination of the switch being present and stimuli appearing on the screen. In this example, an additional form of instructional support, faded over time, is imposed on the computer task. In the match-to-sample format, students often impulsively responded to the appearance of the match and distractor(s), rather than attending first to the target and then searching for the match. The teachers attempted to shape student attention to the appropriate stimuli by covering the matches until the student had directed his or her attention to the target. While the length of time the switch was available to the student gradually <u>increased</u>, the covering of response distractors <u>decreased</u> over time.

Once the student made a response, the teacher also participated in the feedback and reinforcement component of the instructional chain. Teacher-supplemented feedback in the instance of correct responding frequently involved verbal reinforcement and specification of <u>what</u> response was being reinforced (e.g., "Good. You found the ____."). Similarly, corrective feedback, typically not provided in a meaningful fashion for

Table 7

Sample Teacher Procedures Used with Computer Instruction

Steps in Instructional Sequence
Step 1: Target stimulus, one match
Cycle 1 - Teacher covers match, directing student's attention to the target stimulus.
Cycle 2 - Teacher uncovers match, moves box to surround correct response, and places switch in front of student when box surrounds correct response.
Step 2: Target stimulus, one match
Cycle 1 - Match is uncovered; teacher directs student's attention to the target stimulus.
Cycle 2 - Teacher moves scanning box to surround correct response; switch is placed in front of student when box surrounds the correct response.
Step 3: Target stimulus, one match, one distractor
Cycle 1 - Match and distractor are covered; teacher directs student attention to stimulus
Cycle 2 - Teacher uncovers match and distractor, moves scanning box to correct response. Switch is placed in front of student when box surrounds correct response.
Step 4: Target stimulus, one match, one distractor
Cycle 1 - Match and distractor uncovered; teacher directs attention to stimulus.
Cycle 2 - Scanning box moved to surround correct response; switch is placed in front of student when box surrounds correct response.
Step 5: Target stimulus, one match, one distractor
Cycle 1 - Match and distractor uncovered; teacher directs attention to target if student is not attending.

Cycle 2 - Scanning box moved to surround correct respose; switch placed in front of student immediately BEFORE box surrounds answer.

Step 6: Target stimulus, one match, one distractor

Cycle 1 - Match and distractor uncovered; teacher directs child's attention to target stimulus if student not attending to it.

Cycle 2 - Teacher moves scanning box to surround correct answer; switch is placed in front of student during entire trial.

Step 7: Target stimulus, one match, two distractors

Cycle 1 - Matches uncovered; teacher directs child's attention to target stimulus if child is not attending to it.

Cycle 2 - Teacher moves scanning box to correct answer; switch placed in front of student during entire trial.

Step 8: Target stimulus, one match, two distractors

Cycle 1 - Matches uncovered; no teacher direction.

Cycle 2 - Teacher moves scanning box to correct answer; switch placed in front of student throughout trial.

students within the software, pointed out the nature of the a student's error (e.g., "Here is the ____.").

Student grouping. For the most part, computer activities were conducted on a one-to-one basis. However, the feasibility of working in small groups was investigated in several project classrooms. As described in greater detail in relation to the development of social interaction skills, students were paired with a more capable peer for compter-based leisure activities to develop appropriate social behaviors. The moveable keyboard on the new Apple GS will provide greater flexibility to investigate group arrangements with a variety of students.

Student Performance

The original grant proposal established objectives to identify and use commerically available software as well as programs created with the MACS authoring system with students in project classrooms. A description of this software, as well as comments and recommendations regarding software characteristics, have already been presented. The following section contains observations regarding student performance in relation to these programs. A more detailed description of skill acquisition and generalization based on a controlled research study is contained in a paper that is abstracted in Appendix D. The abstract of a second investigation, focused on using the computer to promote social interaction, is included in Appendix C.

Skill acquisition and generalization. The question "Can students with severe handicaps learn skills from the computer that are typically taught in other ways?" is one that was addressed with great difficulty during this

project. It is evident that a computer medium can provide a responsive environment for developing and practicing contingent responding and basic motor skills. Evaluating programs designed to teach conceptual and language skills is a less straightforward task with students with severe handicaps. The response format of instructional software for this population (i.e., scanning box) superimposes a cognitive demand upon the student which extends beyond the task itself. Some students, for example, indicated a knowlege of "which picture is the same" by pointing to the screen or visually directing their gaze at the correct response, yet failed to respond correctly within the switch/scanning box format. For other students, it was difficult to know whether it was the task items, format, or combination of the two which was the source of difficulty. A fair evaluation of the instructional utility of the computer must rely upon input modalities which do not complicate the task. At this point in time, the Touch Window (when compatible software becomes available) and the Unicorn Board/Adaptive Firmware Card combination appear to offer the greatest chance of separating out response from task requirements. Future investigations with this population should consider these student input configurations.

Social interaction. On the basis of classroom observations and the results of the study reported in Appendix C, the use of a computer context to develop social behaviors and promote interaction between students appears to be a promising area for further investigation. The reinforcing value and age appropriateness of computer activities is an obvious asset. This is especially important in student groups involving handicapped and nonhandicapped students. The ability to use peripherals to compensate for

the skill deficits of handicapped students creates a situation in which a student can interact with his/her peer on a more equal basis. This context appears to be a prerequisite for student-student interactions that are social rather than instructional in nature.

Staff Training

None of the participating teachers had had previous computer experience prior to this project. A two part training program for teachers was conducted at the beginning of each phase. The first part of the training consisted of four two hour sessions designed to train teachers how to handle and operate the computer, load and use instructional software, use alternative input devices with their students, and use the AppleWorks word processing program (see session outlines in Appendix E). Due to School District policies requiring the payment of teachers for their participation in after-school staff development, this phase of training was limited to the bare essentials.

Follow-up training was provided in the form of on-site technical assistance to project teachers. The project coordinator visited each classroom, answering questions and providing feedback to teachers regarding the programs selected for students, the adequacy of the input devices selected for students, the training procedures used with students, and the arrangement of the equipment in the classroom. Later in the school year, an additional group training session was conducted in the use of MACS, an authoring system.

Records of scheduled follow-up visits indicate that a majority of this time was spent providing additional instruction in the use of software, especially in the use of AppleWorks. The second greatest area of need was

equipment-related problems (e.g., how to adjust the volume on the ECHO speech synthesizer, adjusting the picture on the monitor, etc.). This same pattern is evident in records maintained regarding teacher-initiated requests for assistance. Over 50% of these requests involved problems in the use of either AppleWorks or MACS, the authoring system which was made available to teachers. Twenty-five percent of teacher-initiated requests involved equipment problems, and the remainder of these contacts were made to get additional supplies or programs.

Informal feedback from teachers indicated a need for more extensive training, particularly in the use of word processing software. There was a clear difference between teachers who had typing skills and those who did not in their ability to use and benefit from AppleWorks. The program's potential for time savings is not the immediate concern of typers at the "hunt and peck" level.

Teacher observation also revealed that the amount of time required to become proficient in even basic computer use cannot be minimized. The relatively brief period of time encompassed by this project and the number of areas in which applications were targeted created a situation in which teachers were presented with a diverse range of new possibilities in a very short period of time. Time is required to absorb and apply these new skills to classroom situations. The amount of time remaining after teachers were trained, particularly for Phase II classes, was insufficient to accurately evaluate the utility of the computer in these classrooms.

The results of a survey summarizing teacher perceptions of the training provided are presented in Table 8. The two areas ranked the highest - the use of word processing and the use of hardware - were those

that received the most emphasis in training. The teachers did not feel adequately prepared to select software, perhaps reflecting the relatively limited pool of programs available for their students. The area of data management, also receiving relatively little emphasis, was ranked low in regard to training.

Insert Table 8 about here

Additional training provided by project staff members included those individuals who serve as instructional support personnel to teachers of students with severe handicaps. Seven instructional advisors attended a two part training session which provided them with an overview of the possibilities for computers in classrooms for moderately and severely handicapped students. This involvement led to the dissemination of product information, recommendations, and assistance to other teachers throughout the district.

Dissemination Activities

Project staff members participated in a variety of activities to disseminate information about computer applications for students with severe handicaps. The two main audiences for this information are consumers (teachers, parents, administrators) and researchers (technology specialists, university professors). These activities included conference presentations and the development of written materials.

Table 9

Teacher Perception of Project Training Activities

Training Area	Average Rating*
Use of hardware	3.4
Word processing	3.2
Authoring use (MACS)	2.9
Computer literacy	2.8
Applications of software in student instruction	2.3
Data management	1.5
Selection of software	1.4

*Rating based on the following likert scale:

0 = not adequate
2 = adequate
4 = very useful

A listing of presentations and a description of the audiences is presented in Table 9. In addition to these dissemination activities,

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Insert Table 9 about here

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a presentation on this project is scheduled at the forthcoming Technology and Media (TAM) division of CEC meeting that will be held January 15-17, 1987. As they are completed, the documents referenced in Appendices A through E will be made available to interested parties and/or submitted for publication to appropriate professional journals. These journals include but are not limited to the Journal of the Association for Persons with Severe Handicaps, Journal of Special Education Technology, Teaching Exceptional Children, and Classsroom Computer Learning. Additional information will be shared through newsletters such as those published by TAM and the Mid-Atlantic Association for Persons with Severe Handicaps (MASH).

A file of correspondence containing inquiries about the project has been maintained. Thirty requests have been received and answered to date.

Table 9

Dissemination Activities Conducted by Project Staff

Date	Project Staff	Title	Audience/Event
April, 1985	Larsen/McGregor	The use of microcomputers in programs for students with severe handicaps*	6th annual conference, Young Adult Institute, New York City
May, 1985	McGregor	Socialization through technology:	11th annual convention, Association for Behavior Analysis, Columbus, OH
May, 1985	Larsen/McGregor	The use of microcomputers in programs for students with severe handicaps: Management and instructional applications.	11th annual conference, DC Association for Retarded Citizens
October, 1985	McGregor	Computer applications in classrooms for students with severe handicaps	Annual Closing the Gap Conference, Minneapolis
December, 1985	McGregor	Microcomputer applications in class-	12th annual TASH conference, Boston
May, 1986	McGregor	The use of computers to provide habilitative services.	12th annual conference, DC Association for Retarded Citizens
April, 1986	McGregor	Computer applications for students who have severe handicaps.	CEC Software Conference, Washington, DC
June, 1986	McGregor	The use of microcomputer-based adaptations to increase the social interaction between students with handicaps and their non-handicapped peers.	CEC 2nd Annual Invitational Research Symposium, Washington, DC
September, 1986	McGregor	The use of technology in educational programs for students with multiple handicaps*.	CEC Symposium for Low Incidence Populations, Atlanta, GA
November, 1986	McGregor	Computer applications with students with severe handicaps.	Inservice training workshop, Maryland School

*Paper is published in monograph of conference proceedings.

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APPENDIX A

Computer Management of Information in Classrooms Serving Students with Severe Handicaps

Lewis Jackson, Allen Spurr, & Gail McGregor

Data gathering activities within classrooms serving students with severe handicaps should be designed to provide instructional and administrative personnel, parents, and others with information which enhances their management and contribution to the educational service delivery process. Decisions that are made by teachers and others that affect student placement, IEP development, the provision of special services, and the provision of instructional activities can be made with greater confidence if they are based on qualitative and quantitative performance data which are systematically collected and carefully analyzed. The classroom-based microcomputer can provide a means for collecting, retaining, and analyzing student performance data. Two distinct classes of data-based software can be identified. First, certain instructional software programs have built-in data management capabilities. Second, software packages are available which are dedicated exclusively to the management and analysis of student performance records. Problems associated with microcomputer management of information include (a) limitations in software design, (b) measurement problems which reflect the impact of specific student handicaps, and (c) the absence of data-based management skills on the part of teachers and others. A number of solutions to these problems are proposed.

APPENDIX B

DRAFT

The Use of Technology in Educational Programs For Students with Multiple Handicaps

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Paper presented at the Council for Exceptional Children's Symposium for Low Incidence Populations, Atlanta, Georgia, September 18-20, 1986. This activity was supported by Grant No. G-00-84-30069 awarded to the Johns Hopkins University by the U.S. Department of Education. The opinions expressed herein do not necessarily reflect the policy of the U.S. Department of Education and no official endorsement should be inferred.

Technology Applications in Educational Programs For Students with Multiple Handicaps

Despite the legal assurance of an appropriate education for all students with handicaps, the provision of services for low incidence populations - those students with severe, multiple handicaps, continues to generate controversy. In courtrooms and in professional writings, the question of "educability" has been debated (Baumeister, 1981; Burton & Ashoren, 1979; Lehr & Brown, 1984; Noonan, Brown, Mulligan & Rettig, 1982; Sontag, Certo & Button, 1979). On one side, there are those who argue that some individuals are incapable of learning a significant number of meaningful skills (Kauffman & Krouse, 1981). "Heroic" efforts to train unresponsive individuals are considered harrassment by those who feel these expectations are inappropriate (Bailey, 1981).

In contrast, the belief that all children with handicaps can profit from education is based on a different set of assumptions. One is that "educability" is now a legal concept (Martin, 1981). The fact that the term may have originated with, and retains a meaning among educators, is no longer of consequence. Philosophically, current policies regarding the education of students with handicaps are attributed to a set of generally accepted social and political values. According to Turnbull and Turnbull (1978), a belief in the essential sameness of all persons, that government benefits should not be contingent upon unalterable characteristics of a person, and the belief that education makes a difference, are assumptions that have influenced public policy on behalf of students with handicaps.

From a pragmatic perspective, a recognition of the limitations of our present instructional technology, as well as the inadequacy of previous and current services, prohibits definitive conclusions regarding educability or its limitations (Orelove, 1982). In a discussion of his testimony in the Wyatt v. Hardin right-to-treatment case (Petitioner's Motion for Modification, 1978), Baer (1981) concludes "I have failed to teach quite some number of profoundly retarded children, yet in the face of such failure I have succeeded often enough in teaching them by trying something different (not always - just often enough) that I will affirm, not as a statement of fact but as a statement of policy, that I will proceed as if all children are capable of learning under instruction (pg. 93)."

Low incidence populations constantly challenge our abilities, practices, and creativity in the search for that "something different" that will be successful in instructional programs for these students. Advances in the

field of microtechnology have led to the development of new tools that hold great promise in providing instruction and increasing a student's independence. Technology can also assist the teacher in performing time consuming program support activities. After establishing important characteristics of instructional programs for students with multiple handicaps, the role of technology in providing these services will be examined. Direct applications with students, as well as program support and management activities will be considered.

Program Goals for Low Incidence Populations

Since the mid 1970's, services for students with severe handicaps have undergone a major transformation. Programs which emphasized custodial care in segregated settings have been challenged to adopt and operationalize the "criterion of ultimate functioning", the belief that the demands of a full range of normalized school, work, and community settings should guide the selection of training goals and activities for students with severe handicaps (Brown, Nietupski, Hamre-Nietupski, 1976). A developing instructional technology is being used to provide training that utilizes "real" materials and naturally occurring cues and consequences in the context of functional activities in integrated settings.

The relevance of this orientation may not be readily apparent to a teacher of a high school student whose assessments indicate that he is functioning at the 6 to 12 month level. However, a second premise underlying curricular decisions for students with severe handicaps, the principle of partial participation (Baumgart, Brown, Pumpian, Nisbet, Ford, Sweet, Messina & Shroeder, 1982), relates to this concern. Recognizing that not all students with severe handicaps will be able to acquire skills that enable them to function independently in a range of school and nonschool settings, the principle of partial participation states that involvement to the greatest degree possible is preferable to exclusion from those activities. Through direct and systematic instruction, students should be taught those skills that will allow them to function, at least in part, in a variety of normalized settings.

Technology and Partial Participation

In practice, planning for partial participation usually requires the use of some type of adaptation, i.e., an adjustment or modification that allows or increases the degree to which a person can participate in an activity. As described by Baumgart et al. (1982),

> An individualized adaption is one that is personalized and enables a particular student to participate at

> least partially in a particular chronological age appropriate and functional activity. This is done by enhancing the performance of existing skills, compensating for missing skills that will not likely be acquired, and allowing for the acquisition and utilization of alternative skills (pg. 20).

Adaptations vary considerably in the means and degree to which they enable an individual to participate in an activity. Some adaptations can be described as contextual, in that they involve minor changes in the environment. Providing personal assistance is probably the most frequently used adaptation of this type, e.g., pulling the lever on a vending machine to get the item a student has just pointed to. A rule change, e.g., allowing a student to begin changing classes slightly before the bell rings so that he will get to the next activity on time, is another type of contextual modification.

The introduction of specialized materials and devices represents a "technological" approach to partial participation. Special educators have long recognized the value of these innovations in maximizing the development of students or overcoming barriers to their participation (Joiner, Sedlak, Silverstein & Vensel, 1980). While sophisticated devices such as the Optacon, talking calculator, or paperless braille machine may come to mind, there are many "low tech" strategies that are widely used with students who have multiple handicaps. A program developed for an adolescent with severe handicaps, described by Browder and Martin (1986), exemplifies the use of the principle of partial participation and its accompanying individualized adaptations within the framework of a functional "life skills" curriculum.

Tommy is 12 years old and resides in a residential facility for individuals classified as severely and profoundly mentally retarded. His strengths and weaknesses are described as follows:

> He has spastic quadriplegia, seizures, scoliosis, and severe asthma, and does not respond to visual stimuli. Tommy is able to voluntarily move one arm, nod his head, smile, laugh, and cluck his tongue. Before his new curriculum was implemented, he had no recognizable expressive communication. On the Bayley Scales of Infant Development and the Vineland Social Maturity Scale, Tommy has scored below the 2 month level. Tommy's individualized education program (IEP) has included skills from the 2- and 3-month developmental level for his entire school career. In the past, his lack of progress has been attributed to the severity of his handicaps (pg. 261).

Developmental scales are quickly abandoned as a basis for selecting program goals with students of this age. Instead, an ecological inventory (Brown, Branston, Hamre-Nietupski, Pumpian, Certo & Gruenewald, 1979) was conducted by the teacher in conjunction with Tommy's grandmother. The purpose of this inventory was to identify current and future residential, recreational, and work settings. A comparison of the skills required to participate in these settings with Tommy's current abilities led to the identification and prioritization of his educational needs. Briefly, the following settings, skills, and activities were selected.

1. Current Environments - Presently, Tommy spent all his time in his medical residence and his grandmother's home.

2. Future Environments - Tommy's grandmother wanted him to accompany her to community settings, such as a shopping mall and restaurant. His teacher identified environments that would provide Tommy with recreational, vocational, and community experiences. These included the local YMCA, community-based health facilities, a van for transportation, the senior citizen center in which his grandmother lived, and a group home.

3. Current Abilities - Skill deficits which had led to Tommy's exclusion from most activities included the lack of a communication system, poor head control, lack of physical stamina, and severe asthma. These deficits also resulted in total dependence upon others to perform life skills.

4. Skill Assessment - The teacher undertook several assessments to identify a starting point for instruction. Assessments were conducted to identify a reliable response which might form the basis for a communication system and a movement which could activate a switch to provide recreation and vocational opportunities. Tommy's physical stamina was assessed by determining his tolerance for wheelchair travel. His tolerance for water was evaluated by placing him in a wading pool. Finally, the teacher assessed his ability to participate in his daily routine.

5. Assessment Results - The teacher found that in response to recorded tapes of Tommy's grandmother, his most consistent voluntary response was a clucking of the tongue. Observing Tommy's efforts to activate his tape recorder, his range of motion was assessed. He could not use his hands; however he was able to move one arm vertically and

horizontally, approximating the response needed to activate a flipper switch. In a wheelchair, Tommy did not hold his head up independently. If pushing the chair was made contingent upon holding his head erect, Tommy did demonstrate the ability for short periods of time. Tommy startled and tensed when placed in the water of a wading pool. Finally, he was observed to smile during dressing in response to comments about his clothes, could hold his head up when the teacher put his t-shirt on, and lowered his arms after they were put in the sleeves.

6. Training Goals - The following skills were identified as priority training goals for Tommy:

   -a yes/no communication system
   -partial participation in self-care routines
   -use of a flipper switch
   -tolerance for wheelchair travel

7. Training Activities - In keeping with the concept of the criterion of ultimate functioning, these skills were taught in the context of real life activities. His curriculum plan, as delineated by Browder and Martin (1986), is summarized in Table 1.

Insert Figure 1 about here

Microcomputer Applications

Would a microcomputer make any difference in a program for Tommy or students like him? Based on current software and peripheral availability, instructional and management functions which could be performed with the assistance of a microcomputer will be described.

Instructional Applications

Response-contingent learning. Studies of early learning have revealed that infants are highly competent, making a connection between an operant response and its related environmental stimuli as early as two months of age (Hulsebus, 1973). Watson (1966) first suggested that "contingency awareness" was the basis for a generalized cognitive awareness of the relationship between behaviors and their consequences. Research has demonstrated the importance of contingent feedback in the context of both physical and social interactions (Brinker & Lewis, 1982a) and its subsequent impact on the motivational, cognitive,

attentional, and affective behavior of infants (Hanson & Hanline, 1985).

Students with significant handicaps are at great risk in regard to the development of contingency awareness. The presence of sensory and motor impairments restrict opportunities to experience a variety of physical contingencies. Social contingencies may also be disrupted between the child and parents unprepared to effectively interact with a handicapped child, or for children who are cared for by many careta' rs in a residential facility. Without an opportunity to learn that their actions can affect and control the environment, many children with handicaps exhibit "learned helplessness", an extreme passivity and disinterest in their environment (Seligman, 1975).

For many of these students, plann ng and environmental modifications are necessary to enable students to learn response-contingent behavior. Electromechanical and adaptive devices have been effectively used to provide contingent feedback in teaching students to increase the incidence of low frequency behaviors (Hanson & Hanline, 1985; Haskett & Hollar, 1978). However, most students will require systematic instruction to establish and maintain the responses required to activate these devices (Meehan, Mineo & Lyon, 1985). Computers have been used for this type of instruction, as a means of activating other devices (Brinker & Lewis, 1982b), and as a source of feedback.

The advantages of electromechanical devices have been described by Hanline and colleagues (Hanline, Hanson, Veltman & Spaeth, 1985).

1. A wide variety of activating devices are available to accommodate different physical, cognitive, and sensory impairments.

2. They are motiviating to children because they provide new and salient feedback.

3. They may be reinforcing to students who are not responsive to social reinforcement, or those whose sensory impairments limit the reinforcers available to them.

4. They deliver consistent, immediate feedback.

5. The feedback and the child's response are related, providing a functional interaction with the environment.

6. Minute changes in behavior can be detected.

7. These activities can be used to supplement other contingency experiences provided by teachers and parents.

8. Materials are durable, nonconsumable, and can be used by more than one child (pp. 20-21).

In using a computer for this purpose, it is necessary to have an effective means of input for the student. A wide variety of single switch devices are commercially available[1], or switches can be economically constructed by instructional personnel (see Burkhart, 1980, 1982) to accomodate most any student. Several software programs are available to assist in the identification of an effective switch input for a given child (Expert Systems, Inc., 1985; Rushakoff & Hansen, 1984). A common feature of these programs is the computer's calculation and storage of response latency, i.e., the amount of time required for a student to activate a switch after a stimulus has been presented. By comparing student performance across different input devices and placement configurations, the combination which results in the most proficient performance can be systematically determined.

Once an effective input has been identified, several games which require single switch input are available to enable students to engage in response-contingent activities (e.g., Motor Training Games; Switch Master). Although this type of software is rather limited in scope, it is possible to adapt off-the-shelf programs with engaging graphics and animation for this purpose. The Adaptive Firmware Card (Adaptive Peripherals, 1983) is a device which provides transparent access to the Apple IIe computer for individuals who are unable to use the standard keyboard. When the card is activated, a scanning array is superimposed on the bottom of the screen. By activating a single switch to stop a moving cursor, a student is able to enter a response without using the keyboard. Customizing capabilities of the Adaptive Firmware Card enable the teacher to design a scanning array for a particular piece of software, including only those numbers or letters which are required to use the program. Through careful selection and customization, engaging, age-appropriate activities can be developed for students with limited abilities.

Students are also able to input responses in the computer through the use of some type of membrane or touch sensitive surface. The Unicorn Board, used in conjunction with the Adaptive Firmware Card, provides a large surface which can be defined to mean any character or set of characters that is required by a student to use a program.

[1] A resource list is contained in Appendix A.

A light touch on this surface is then conveyed to the computer as input. The Touch Window (Personal Touch Corporation, 1985), another alternative to keyboard input, is a device which can be mounted over the monitor, acting as a touch-sensitive screen. It can also be used horizontally as a graphics tablet or a large switch.

Choice-making. Switch activity, while important for the development of contingency awareness, is not an end in and of itself. Rather, switch activation is the first step in using technology for more advanced and meaningful activities. One of these is the ability to make choices. Until recently, curricula in educational programs for students with severe handicaps neglected the behavior of making choices, decisions, and expressing preferences (Guess, Benson & Siegel-Causey, 1985). A conscious effort to provide these opportunities is critical for individuals who do not exhibit this ability, and have limited response repertoires available to them.

The choice making activity most frequently seen in classes for students with severe handicaps is the selection of reinforcers (Raschke, 1981). The Toy Preference program accompanying an interface device called the Omni Box (Expert Systems, Inc., 1985) assists a teacher in sampling a child's reinforcement preference from among up to four different battery operated devices at one time. While this information can be used by adults to structure an instructional situation which is likely to result in optimal student performance, the activity is also valuable in and of itself as a vehicle to teach the expression of preferences.

Choice Maker (Lahm, 1985) is another program designed to enable students with limited response repertoires to control their environment. Through a series of nine carefully structured lessons, students a taken from the point where they learn that a switch will activate a battery operated toy, to the point where they can express preferences by selecting one of four switches which activate different devices.

Communication and environmental control. Technological advances have increased the range and efficiency of electronic communication devices available to students with severe handicaps. For students with multiple handicaps, however, nonelectronic systems which are simple and concrete are often the method of choice. Nevertheless, some inherent drawbacks to nonelectronic systems, as well as the changing communication needs of a student, may warrant the consideration of a more sophisticated system in some situations.

Advantages associated with electronic systems for students with severe handicaps have been described by Hooper

and Hasselbring (1985). The following are of most relevance for students with multiple handicaps.

1. Electronic aids can reduce the number of movements needed and increase the rate of communication, reducing the fatigue a student experiences.

2. A large number of language items can be directly accessed by the child.

3. The child can access the board without assistance and the message can be "stored" on the display until someone is able to acknowledge its occurrence.

4. The electronic aid may allow a broader audience to communicate with the child especially if the aid has an auditory speech mode.

5. Many electronic systems provide the child with a permanent product of their communication that can be used to communicate to individuals who are not in the immediate environment (pp. 40-41).

The addition of a voice synthesizer, specialized input devices, appropriate software, and a printer turns a computer into a flexible electronic commnication device for students with a wide range of handicaps. Its use as a beginning communication device for nonoral students with physical handicaps is exemplified by the work of Meyers (1984). With the computer, Meyers seeks to emulate the dialogues that occur between child and caretaker during play routines. These interactions enable children to successfully communicate through gestures, vocalizations, and the manipulation of objects.

Meyers describes one effort involving a 26 month old children who was nonvocal, blind since birth, and had cerebral palsy. Based on information provided by the parents, an intervention based on the child's preference - having songs sung to him, was designed. An Apple computer was equipped with a membrane keyboard and voice synthesizer, programmed so that when it was touched, the work "sing" was spoken. Through a gradual shaping process, the child's motor responses became coordinated and a causal relationship between the keyboard and the vocal response was established during interactions with his mother. After the child had learned that he had to touch the keyboard in order to get his mother to sing, the same strategy was extended to other situations, e.g., asking for more food when eating, asking to hold his favorite toy. In the future, the keyboard would be expanded so that he could sequence words, such as "more", "sing", and "eat".

Other programs are available which turn the computer into a communication device rather than as a tool to promote communication (Cohn, nd, a, b; Rushakoff, 1984). While accessible through specialized inputs, these programs require significant cognitive skills on the part of the user.

Recreation and leisure. Without systematic instruction, students with severe handicaps frequently fail to develop a repertoire of skills that enable them to constructively occupy their leisure time (Wehman & Schleien, 1981). Not only do leisure skills increase a student's opportunities for involvement with others, leisure skill instruction has been associated with the development of collateral skills (Voeltz & Wuerch, 1981) and the reduction of maladaptive behaviors (Flavell, 1973; Schleien, Kiernan & Wehman, 1981).

Normalization, age-appropriateness and student preferences are three important considerations in the selection of recreation activities (Putnam, Werder & Schleien, 1985). Microcomputer based recreation activities score high in relation to each of these concerns. Furthermore, the ease of incorporating adaptations which enhance independent performance is another valuable characteristic.

In the context of computer games, other valuable skills can be taught or practiced. Switch based activities provide an excellent context for motor skill development. For many students, voluntary control over the depression and release of a switch can be practiced during computer activities (e.g., Frog and Fly - Motor Training Games; Switchmaster - Expert Systems, Inc., 1985). For students who have some proficiency at switch use, a program called "The Scanning Game" provides an enjoyable activity in which a child learns to coordinate visual scanning with the activation of a switch. Different versions of the game allow teachers to provide instruction individually, or in the context of a small group. In small group instuction, the game can be structured by the teacher so that during each student's turn, s/he is responding to stimuli presented at a speed and level of difficulty which is individualized. In other video games, the use of a joystick provides practice in "reaching and grasping", an important skills for many students with physical impairments.

As a context for integration, computer games provide an activity in which both special and regular education students can enjoy themselves. Once again, the ability to use peripherals to enhance a student's ability to participate in this task is an asset that can be exploited by teachers. In addition to the use of switches and/or adapted joysticks, the Adaptive Firmware Card has a Slow

Down function which enables a teacher to regulate the speed of a game. Through the construction of custom menus, teachers can use the Adaptive Firmware Card to allow students access to computer games through a single switch rather than a joystick or the keyboard.

Program Management and Support Activities

At the school and district level, there are many areas into which microcomputers are effectively integrated in an information management system (Ragghianti & Miller, 1982). For the present, however, this discussion will be limited to management and support applications which occur at the classroom level.

Data management. In order to meet the accountability requirements of P.L. 94-142 and provide quality instruction, teachers are faced with significant paperwork and management tasks. Monitoring progress and making data-based instructional decisions for every student are two of these responsibilities which require substantial time commitments from the teacher. At least two software programs (Cruscial & Schimmer, 1983; Hasselbring & Hamlett, 1983) have been designed to assist teachers in this area. Studies have found that computer managed instruction results in a 25 to 30% savings of time as compared to manual methods of performing the same tasks (Baumgart & VanWalleghem, 1984; Detwiler, 1982). For purposes of illustration, the features of AIMSTAR (Hasselbring & Hamlett, 1983) will be described.

AIMSTAR was designed to assist teachers in providing data-based instruction. Using this program, teachers enter program descriptions, instructional methods, and student performance data. Once entered, teachers can obtain printed reports and a graphic display of student performance data. The charted data are compared to a students "aim rate", a line of progress calculated on the basis of a student's start and anticipated completion date of instruction. Futhermore, the teacher can have data analyzed in relation to precision teaching decision rules developed by Haring, Liberty, and White (1981). Messages that are generated let the teacher know if instructional changes are warranted based on the students rate of progress. If instructional changes are made, the program file is updated. Thus, a report that provides an instructional chronology can be generated.

Word processing. Close collaboration between home and school is an essential component of quality instruction for students with severe handicaps (Bates, Renzaglia & Wehman, 1981). Teachers frequently rely on written communication to maintain close contact with families. For teachers who type, a word processing program can make this task more efficient. In a sample of twelve teachers of students with

severe handicaps participating in a pilot computer project, 100% indicated that they found the computer useful in generating reports and letters (McGregor, in prepration).

Decision-Making in the Use of Technology

It is easy to get caught up in the novelty and attractiveness of technology, such that its use becomes an end in itself rather than a means (York, Nietupski, & Hamre-Nietupski, 1985). Several questions are raised to assist in determining whether a computer is the appropriate means of performing a given task.

1. Is the task educationally valid? An over-infatuation with technology can cause a user to structure activities on the basis of what is currently available rather than educational validity. In instructional applications, the overriding concern is the educational importance of the task. Is the skill/activity in question one that is part of the student's IEP? Is this a skill/activity that has been determined to be significant for increased participation in current and future environments?

2. Will the computer activity reinforce skills that are learned in other contexts? Generalization problems are characteristic of students with severe handicaps. A common teaching strategy to address this problem is to train sufficient exemplars (Stokes & Baer, 1977). If computer activities are closely integrated with training provided in other contexts, the chances of skill generalization are increased.

3. Is the computer time efficient? For both management and instructional applications, the question of time efficiency is relevant. If computers can be successfully used to perform a task in the same or less time as traditional methods, their use is warranted. If not, they need to offer some other advantage over traditional means in order to justify the greater time and expense.

Summary

Microcomputers are a new and available technology for special educators. For individuals concerned with services for low incidence populations, the microcomputer's ability to utilize even a small student response and provide output in a variety of modalities is a great asset. Its usefulness in relation to response-contingent learning, choice making, communication and enviornmental control, and recreation and

leisure skill development has been discussed. Furthermore, the facility with which computers store and manage information can be applied to the many management and recordkeeping tasks associated with special education services. Used within a context in which computers are used to enhance special education services rather than dictate them, they will prove to be a great asset in providing quality services in programs for students with severe handicaps.

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APPENDIX A: COMPUTER RESOURCES

SINGLE SWITCHES

Prentke Romich
1022 Heyl Rd.
Wooster, OH 44691
(216) 262-1984

Computability Corporation
101 Route 46 East
Pine Brook, NJ 07058
(201) 882-0171

Don Johnston Developmental Equipment
981 Winnetka Terrace
Lake Zurich, IL 60047
(312) 438-3476

SWITCH INTERFACE/INPUT BOXES

In order to attach a single switch to the Apple computer, a switch interface device must be connected to the computer in the Game I/O recepticle. Switch interfaces which accomodate either single or multiple switch inputs can be purchased or constructed. The commercial vendors listed above under "SWITCHES" also sell interface devices.

A specialized input device, called the OMNIBOX, has been developed by:

Expert Software, Inc.
923 Van Leer Drive
Nashville, TN 37220. Cost: $249.00

Once again, input boxes can be made at home for a fraction of the cost of commercially distributed devices. Directions for a Four Hole Switch Input Box can be obtained from: Project ACTT, 27 Horrabin Hall, Western Illinois University, Macomb, Illinois 61455.

ADAPTIVE FIRMWARE CARD

Adaptive Peripherals
4529 Bagley Ave. North
Seattle, WA 98103
(206) 633-2610 Cost: $395.00

UNICORN BOARD

Unicorn Engineering Co.
6201 Harwood Avenue
Oakland, California 94618
(415) 428-1626

KEYBOARD SHIELDS

Adaptive Technology, Inc.
5334 72nd Circle North
Brooklyn Center, Minnesota 55429

TOUCH WINDOW

Personal Touch Corporation
4320 Stevens Creek Blvd.
San Jose, CA 95129

DOMAIN: Domestic — **ENVIRONMENTS: Current:** Medical residence; Grandmother's home; **Future:** Group home

Subenvironments	Priority Activities	Priority Skills for IEP
Bedroom	Participating in dressing	1. Communicate choice 2. Move arms to help put shirt on
	Ringing buzzer for help	1. Activate switch 2. Respond to yes/no questions
Bathroom	Participating in bathing	1. Move arms on command 2. Maintain head control 3. Participate in face washing
	Participating in personal hygiene	1. Communicate need to be changed
Dining room	Eating	1. Communicate choice 2. Indicate when full 3. Drink from a straw
	Socializing	1. Eat in presence of people and noise 2. Communicate greetings 3. Wait turn to be fed without crying
Living room (see Recreation)		

DOMAIN: Recreation — ENVIRONMENTS: Current: Medical residence; Grandmother's home; Future: YM/YWCA; Events at theater or college

Subenvironments	Priority Activities	Priority Skills for IEP
Living room	Listening to tapes	1. Select tape 2. Activate switch to turn tape player on/off 3. Ring buzzer to help to change tape
Library/living room	Listening to stories read from books	1. Select book 2. Respond to yes/no questions about book
Outdoors	Swinging in wheelchair swing	1. Indicate desire to swing and to stop 2. Maintain head control on swing
	Taking walks in wheelchair	1. Maintain head control 2. Tolerate chair for longer periods of time 3. Respond to yes/no questions about outdoors
Pool	Swimming	1. Indicate desire to get in/out of pool 2. Tolerate water 3. Move arms independently
Theater/bleachers	Observing events	1. Maintain head control 2. Indicate needs (e.g., thirst, hunger, personal hygiene) 3. Respond to yes/no questions about the event

Continued

Figure 1. Sample curriculum plan for Tommy.

DOMAIN: Community		ENVIRONMENTS: Current: Travel Senior citizens center Future: Shopping mall Restaurant Community physician's office
Subenvironments	**Priority Activities**	**Priority Skills for IEP**
Car or van	Traveling without one-to-one assistance	1. Maintain head control 2. Tolerate chair 3. Maintain body alignment
Senior citizens lounge	Socializing	1. Give gifts 2. Use yes/no communication with strangers 3. Play cassette tapes for others
Stores	Buying clothes	1. Communicate choice 2. Maintain head control 3. Tolerate chair
Physician's office	Cooperating with examination	1. Use yes/no with doctor 2. Tolerate examination
Dining area of restaurant	Eating	1. Drink with straw 2. Eat in strange setting 3. Communicate choices

DOMAIN: Vocation		ENVIRONMENTS: Current: Medical residence Future: Senior citizens center or other residences as audiovisual assistant
Subenvironment	**Priority Activities**	**Priority Skills for IEP**
Lounge/living room	Running audiovisual equipment that has been set up	1. Activate switch for on/off 2. Ring buzzer when equipment malfunctions or movie or tape is completed

Figure 1 (continued). Sample curriculum plan for Tommy.

APPENDIX C

ABSTRACT

Promoting Social Interaction Between Students With Severe Handicaps and Typical Peers in the Regular School: The Impact of Cooperative Arrangements

In many cities across the country, students with severe handicaps attend the same schools as their chronological age peers who are not handicapped (Certo, Haring & York, 1984; Stainback & Stainback, 1985). Physical placement in a regular school is necessary to provide students with severe handicaps regularly occurring, longitudinal opportunities to be involved with their peers (Brown, Ford, Nisbet, Sweet, Donnellan & Gruenewald, 1983). Efforts to date, however, clearly indicate that physical presence in a regular school is, in itself, insufficient to insure that students benefit from their proximity to regular students. On the contrary, support from students and staff as well as careful planning is necessary to maximize the opportunities students with severe handicaps have to become involved in school activities (Stainback & Stainback, 1981).

Earlier efforts to mainstream students with mild handicaps provide valuable direction in current initiatives with students with severe handicaps. While mainstreaming programs have yielded mixed results (Carlberg & Kavale, 1980), a number of studies have noted undesirable social outcomes for students with handicaps in regular classrooms, including rejection, stigmatization, and isolation from other students (Gottlieb & Leyser, 1980; Gresham, 1982). Without a conscious teacher effort to structure activities involving heterogeneous groups of students, regular students may feel uncomfortable around students with handicaps, viewing them in a negative way (Rynders, Johnson, Johnson & Schmidt, 1980).

Previous efforts to acquaint regular students with their peers with severe handicaps have indicated that involvement in joint activities is an effective strategy to promote positive social interaction (Voeltz, 1982). Recreation and leisure activities with peers provide a good opportunity for students to experience the "horizontal" or peer-peer type of interaction that characterizes typical friendships (Sailor & Guess, 1983). This experience stands in sharp contrast to the "vertical", or adult-child type of interactions that predominate the social milieu of students with severe handicaps, e.g., parent - child, teacher - child, therapist - child, peer tutor - child.

In order to maximize the likelihood that joint activities will produce positive social interactions, close attention must be paid to activity selection and structure. Care must be taken to choose an activity that meets several

criteria. First, activities should use materials which are age appropriate. While this is a widely recognized characteristic of instructional practices for students with severe handicaps (Brown, Branston, Hamre-Nietupski, Pumpian, Certo, & Gruenewald, 1979), there is data which indicate that nonhandicapped individuals develop more positive perceptions about students with severe handicaps when they are seen participating in functional, age-appropriate activities (Bates, Morrow, Pancsofar & Sedlak, 1984). Second, the activity must be one which is reinforcing to both participants. Finally, there is evidence that cooperatively structured activities are successful in promoting positive interactions between heterogeneous students (Johnson & Johnson, 1983, 1986; Johnson, Rynders, Johnson, Schmidt, & Haider, 1979). In a cooperatively structured activity, students work together to accomplish a shared goal, i.e., student goal achievements are positive correlated. Johnson and Johnson (1986) define this positive goal interdependence as "the perception that one is linked with others in a way that one cannot succeed unless the other does (pg. 555)."

While studies have shown cooperative goal structuring to be superior to competitive or individually structured activities involving students with mild to moderate handicaps and their typical peers (Cooper, Johnson, Johnson & Wilderson, 1980; Johnson & Johnson, 1981; Rynders et al., 1980), this instructional arrangement has yet to be evaluated as a means of promoting positive interaction between students with severe handicaps and their nonhandicapped peers. When considering the inherent skill differences between these students, it is apparent that some type of individualized adaptation (Baumgart, Brown, Pumpian, Nisbet, Ford, Sweet, Messina & Schroeder, 1982) may facilitate positive goal interdependence. In the present study, an adaptive device was added to a microcomputer to facilitate the cooperative structuring of an activity involving a student with severe handicaps and a nonhandicapped peer. The purpose of the study was to evaluate the impact of a cooperatively structured activity on the frequency and quality of interaction between students during a computer activity.

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APPENDIX D

Teaching Object and Word Recognition Skills to Learners with Severe Handicaps using Classroom-based Microcomputers

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Microcomputer assisted instruction is increasingly becoming a popular means for teaching preacademic and academic skills to exceptional students; however, its utility with learners who have severe handicaps has not been adequately researched. Serious questions can be raised about the role microcomputers should play in instruction with individuals who require (a) extensive supervision in the early stages of instruction, (b) training in skills that are functional for day-to-day life, and (c) training in multiple contexts to facilitate generalization. Two case studies are reported which offer insights into the potential role of and problems associated with classroom-based microcomputer assisted instruction with elementary school learners who have severe handicaps. In the first case, the microcomputer was used to teach object identification skills to a student with severe physical and mental disabilities. In the second case, the microcomputer was used to teach vocabulary identification skills to a nonreading student with severe physical disabilities and mild/moderate mental retardation. Skill acquisition results were mixed for both students, and skill generalization was not observed. The implications of these results for using microcomputers with learners who have severe handicaps are discussed.

APPENDIX E

Introduction to the Apple

I. Anatomy of a Microcomputer System

II. Hands On - Apple Presents Apple

III. Demonstration of Peripheral Devices

- A. Voice Synthesizer
- B. Printer
- C. Koala Pad/Power Pad

IV. Computer Applications in Special Education

- A. Computer as an instructional device
- B. Computer as a management tool
- C. Computer as a communication device
- D. Computer as a programming device

V. Project Activities

- A. Instruction
  1. Skill acquisition/generalization
  2. Socialization/communication
  3. Integration
  4. Authoring
- B. Management
  1. Student progress data
  2. Home-school communication
  3. Other paperwork

VI. Training Schedule

VII. Supplementary Readings

Anatomy of a Microcomputer System

A microcomputer system is made up of a number of components, much like a stereo system. The "basics" are illustrated in Figure 1.

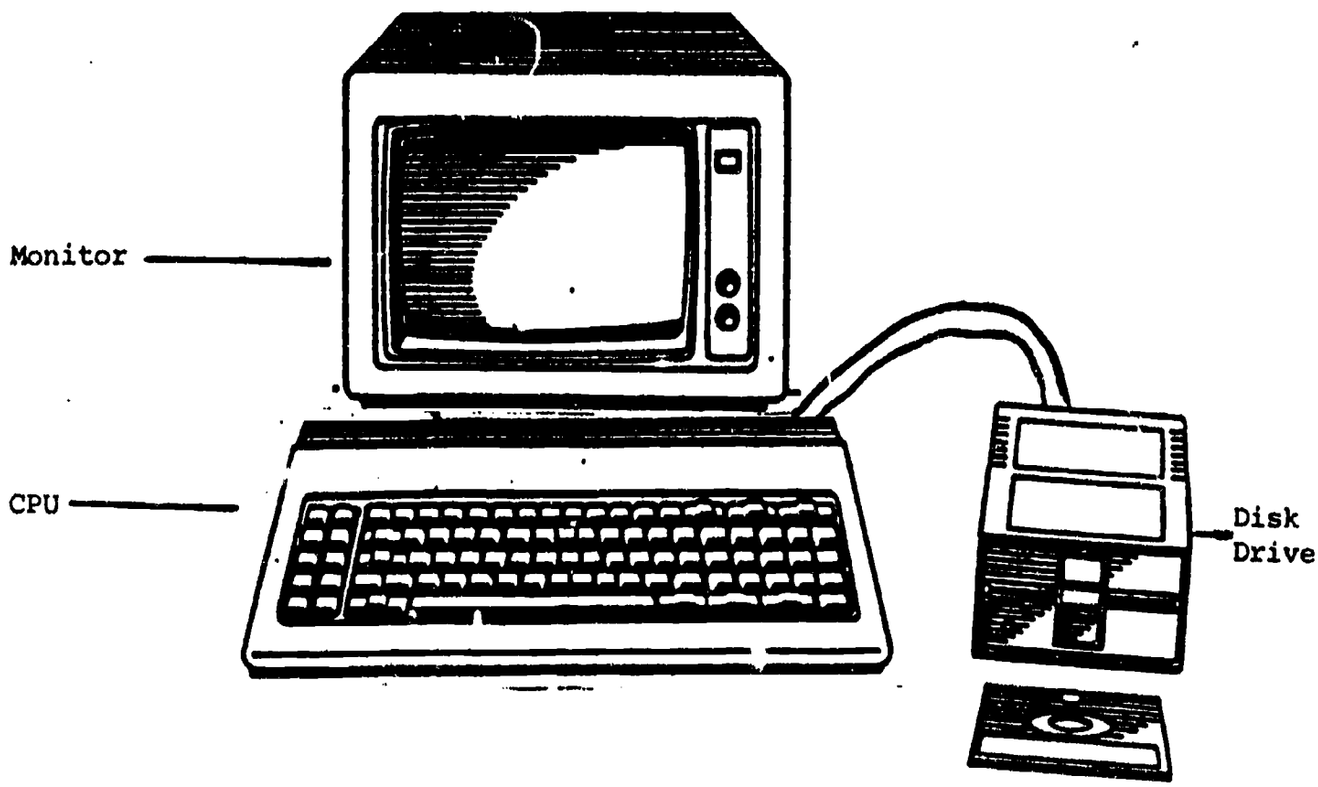

Figure 1. Components of a microcomputer system.

Other components can be added on to expand the capabilities of the system. These are described in the section called "Peripherals".

Central Processing Unit

The "brains" of thje computer are contained in the central processing unit (CPU). The CPU is a maze of electronic circuits which control the flow of information into, and out of, the computer. The computer's memory is contained within this circuitry. The CPU interprets programs, performs the designated functions, and sends the results to the user. In the Apple, the CPU is housed within the system components which contains the keyboard.

Monitor

The screen on which the video display is viewed is called the monitor. It looks and operates just like your television. It could, in fact, be a television if you have the proper connecting device. Some of the more recent television models come "computer ready", eliminating the need for a special connector.

Disk Drive

This is the hardware component in which computer programs, or software, are inserted. While some computers use tape recorders for this purpose, disk drives are more common, and perform more efficiently. The disk drive is connected to the CPU by a thick flexible cable. The cable, in turn, attaches to a card which is inserted into a slot within the CPU. It is important to carefully read the instructions which come with the disk drive before attempting to install this device into the computer.

Getting Started: Basic Operations

In order to get your system up and running, you must first select the program that you want to work with. Handle the disk carefully, holding it between you fingers on the portion of the disk that is covered with a label. Avoid touching any other sufrace areas, since it is easy to destroy the electromagnetic field of the disk. Once you have selected the program you want to use, go through the following steps to insert of "load" it.

1. Turn on the monitor.

2. Open the door of the disk drive.

3. With the label side up, insert the disk into the disk drive.

4. Close the door of the disk drive.

5. Locate the power (on/off) switch on the back of the computer. It is on the lower left hand side of the CPU.

6. Push the switch in to turn the computer on. A green light will appear in the lower left hand corner of the keyboard.

7. The computer will make a beeping noise, a red light on the disk drive will go on, and you will hear a whirring noise.

8. When the noise stops and the light goes out, the disk has been loaded ("booted").

CAUTION: Do not open the door of the disk drive when the red "in use" light is on.

9. The disply you see on the screen will most likely be a "title page" or the "menu" of the disk. The menu, comparable to the table of contents of a book, lists the programs which are stored on the disk. There will be directions for the user which indicate what response is required to retrieve and use a particular program. After making a selection and typing in the proper response, you're ready to go!

Changing Disks

The process of loading a disk when the computer has not previously been in use is called a "cold boot". Should you want to change a disk after the computer is on, it is not necessary to turn off the power to load the new disk. Loading a disk when the computer is already on is called a "warm boot". To perform a warm boot, follow the steps below.

1. Remove the disk previous in use from the disk drive. Make sure that the "in use" light is not on.

2. Insert the new disk, as describe above.

3. With your left hand, place your thumb on the "Open Apple" key located directly to the left of the space bar. Place you left index finger on the Control key.

4. With your right hand, place a finger on the Reset button located on the upper right hand corner of the keyboard.

5. Press the Open Apple down. Immediately after, press the Control and Reset buttons simultaneously.

6. Release the Control-Reset keys. Release the Open Apple key.

7. The computer will beep, the red light on the disk drive will go on, and the drive will begin to whir. As described above, this will steop when the disk has been loaded.

Peripherals

There are a number of optional pieces of equipment which can be added to a computer system. These extras, called peripherals, expand the capabilities of your system in some way. Several of the most common peripherals are described briefly.

Printer. A printer enables the user to get a paper or "hard copy" of information displayed on the screen or stored on a disk. This equipment is essential for word processing and other data management functions possible with a computer. Many educational software programs produce student performance records which can be printed out to place in the student's record, send home to parents, etc.

Modem. With a modem, it is possible to link your computer with other computers and information services. A modem is connected to a telephone receiver, using phone lines to electronically transmit data.

Voice Synthesizer. Your computer will acquire the "gift of gab" with the addition of a voice synthesizer. As the name implies, a voice synthesizer interprets input from the keyboard and transforms it into auditory output. Some educational software is written for use with a voice synthesizer, enabling the student to both see and hear instructional material.

Switches/Joysticks. While the most common means of entering information into the computer is via the keyboard, switch devices and joysticks are alternative methods of inputting a response. They are essential for individuals who are unable to use the standard keyboard, or for the quick responses required in video games.

Graphics Tablet. There are several devices which can be attached to a computer which function as electronic blackboards or drawing pads. Graphic displays drawn on this surface will appear on the monitor, providing an easy way to produce pictures.

Peripherals are connected to the computer in one of two ways. Those which are actually hardware components (e.g., printer, voice synthesizer, modem) are attached to interface cards which are installed in the CPU. They are inserted into one of seven slots which can be seen by taking the cover of the computer off. The less sophisticated add-ons (e.g., switches, graphics tablet), connect to the computer via a small plug with thin metal pins. This plug is inserted into the Game Input/Output port, located inside the computer. Each peripherfal will come with installation instructions which should be read carefully.

CAUTION: Never attach any device to the computer when the power is on.

Session 2

1. The Wonderful World of Word Processing

2. Apple Presents AppleWorks

   Disk 1: Introduction
   Overview
   Gateway

   Disk 2: The Word Processor

3. Preparing to Use AppleWorks

   Copying the Startup and Program Disks

   Specifying printer information

   Operating a printer
   - Printer installation
   - Loading paper
   - Basic functions

4. Word Processing: Writing a Letter to Parents

5. Apple Presents AppleWorks

   Disk 1: Data Base

6. Data Base: Creating a Student Information File

Session 3

I. Review of Word Processing Procedures/Commands

   A. Creating a file
   B. Saving a file
   C. Working within a file

      1. Editing cursors
      2. Deleting information
      3. Inserting information

   D. Printing a file

II. Editing a file

   Exercise: Personalize letters to parents

III. Introduction to the Data Base

   A. Tutorial, Disk 1: Data Base
   B. Exercise: Creating a student file

IV. Creating Labels

V. Student Progress Inventory

VI. AIMSTAR

Session 4

I. Review of Educational Software

A. Program options
B. Use of instructional software

II. Adaptations Through Peripherals

A. Echo
B. Single switch input
C. Matching child to input device

III. Questions and Answer