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THE EFFECTS OF TECHNOLOGY USE BY AN INDIVIDUAL WITH SEVERE OR MULTIPLE DISABILITIES WITHIN THE EDUCATIONAL ENVIRONMENT A CASE STUDY

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By
SARA L. FIELDS
Norman, Oklahoma
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UMI Number: 9935532

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

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USE OF PSEUDONYMS

To protect privacy, the actual names of participants or references to schools, cities, or states are not used in this work. With one exception, all proper names and localities in this dissertation are pseudonyms, as requested by the Internal Review Board of the Research Office of the University of Oklahoma. With permission from his parents, Travis' real name is used.

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ABSTRACT

This case study examined the impact of technology use by a student with severe and multiple disabilities on factors such as achievement, learning, inclusion, social interactions, motivation, behavior, self-esteem, or the attitudes of significant others (teachers, peers, etc.) in the educational setting. Qualitative methodologies were used to follow the educational activities of Travis, an 11-year old student entering the 4th grade, for a seven month period. Because of severe limitations in the areas of communication, mobility, cognition, range of motion, and motor skills, Travis was a prime candidate for assistive technology.

Assistive technology was found to impact the educational environment in many ways. Communication and computer use were the areas where the most significant impact was observed in Travis' educational program. Technology use also impacted affective issues, such as motivation and self-esteem. In addition, the expectations and beliefs of significant others were positively impacted by Travis' technology use. Technology was found to have little effect on his curricular goals, social interaction, or inclusion.

Travis' assistive technology preferences included picture icons and low-tech devices (such as loop tapes or single-switch activities). Effective computer access was accomplished by single switch adaptations, and Travis was highly motivated by autonomous computer use. Travis' performance during structured learning activities at the computer, however, showed great variability. Significant oppositional behaviors occurred at times, particularly when the assigned task was developmentally inappropriate, when

communication efforts went unrecognized, or when Travis' control options were limited. Teachers who used techniques designed to enhance intrinsic motivation saw significantly better attention to task, perseverance, and cooperation from Travis.

The provision of augmentative and alternative communication devices and materials, when properly implemented, provided some opportunities for increased communication. However, little effort by the staff to keep the devices or materials accessible to Travis (within his reach), and inconsistent reinforcement by the staff for the use of those materials was noted as an inhibiting factor.

A number of recommendations for practice were suggested, including the need for proper training of both certified and noncertified staff members.

CHAPTER I: INTRODUCTION

Context for the Study

The Age of Technology is upon us. The impact of technology in today's society is far-reaching, pervasive, and expanding at an unprecedented rate. Rapid innovations and advances in technology are affecting almost every corner of the world. While new technology brings many unforeseen benefits for society, such as an increased accessibility to information and services, it also brings new and difficult problems. As professionals seek to apply new technology to their respective fields, virtually every area of today's modern workplace is experiencing major changes. In schools, perhaps the most profound changes are occurring. Computer-assisted instruction is changing the very nature of public education. The field of education is shifting from a philosophic foundation based upon adult-directed teaching of a static amount of information to student-centered learning via technology-mediated access and use of rapidly growing amounts of information (Raker, 1995; Sparks, 1994). Because of these changes, which are at the very heart of living and learning in today's world, education is undergoing a period of rethinking and restructuring of many of the basic principles of the teaching and learning process (Schiller, 1995).

In the field of special education, technological innovations are resulting in unprecedented change. Technology holds great potential for change in the quality of life for individuals with disabilities, providing the possibility of a more 'leveled playing field' in education, jobs, communication, and recreation (Hutinger, 1993). Until recently, many jobs, activities, educational pursuits, and participation in basic functions of education and life were considered impossible for individuals with significant limitations in their ability to move, talk, or think. New technological tools are changing the boundaries of those limitations dramatically. Activities once assumed impossible for individuals with certain types of severe physical or mental limitations, such as controlling one's own environment, participating in self-care, communicating with others, autonomous decision-making, or learning to read and write, are very quickly becoming within reach (Esposito, 1993; Hannaford, 1993).

New tools and strategies that significantly increase autonomy and independent functioning for individuals with disabilities are rapidly appearing on the marketplace, in the neighborhood, and in the school setting. Innovations in microcomputer technology are causing a significant impact in the field of special education. Educational software has improved dramatically, creating learning tools that have greater flexibility in targeting curriculum to individual needs, that are more purposefully designed to coincide with principles of motivation and learning, and that are much easier for both teacher and student to use (Milone, 1997; Ferguson, 1996). Innovations in adaptive hardware have spawned a whole new class of technical tools for students with severe or multiple disabilities (Esposito, 1993). Individual users can now access educational software via a switch, voice, or touch window, drive a wheelchair with a puff of air, blink an eye to turn on appliances, or use a computer to communicate more effectively. Increased memory capabilities in today's computers have resulted in greater power and flexibility for users with disabilities--providing features such as greater portability, enhanced auditory feedback, and "text-to-speech" interface systems. Computer-interfaced systems have given the user the ability to rely on one device for many different types of assistance----augmentative communication, environmental control, mobility, instruction, access or communication of information via the internet, leisure activities, organizational assistance, cognitive assistance, and/or job-related activities or training (Esposito, 1993).

The idea of using technology to assist an individual with a disability, unheard of twenty years ago, is changing the very meaning of the concept of "disability". As a result of these dramatic changes, conditions are ripe for major philosophical shifts in theories that drive the treatment of individuals with disabilities. Basic changes in underlying beliefs are occurring in the helping fields of education and rehabilitation. These changes involve not only the process of discovering which tools to use and how to best use them, but an axiomatic shift in beliefs, expectations, and attitudes about individuals with disabilities (Hutinger, 1993; Kurzweil, 1990). It is within this context of rapid and unprecedented change that a huge thrust to implement and integrate the use of assistive technology into the lives of students with disabilities is now occurring in the field of education.

Initial Assumptions

In approaching this study, several assumptions were made at the beginning. These include the following:

1) teaching and learning for students with multiple/severe disabilities is multifaceted and depends on a myriad of factors that are interrelated;

2) learning problems for the subjects are pervasive and interrelated;

3) it is unethical to withhold treatment interventions for purposes of research, therefore principles of action research, where research findings

inform treatment, are observed; and

4) In the field of Special Education, individualized treatment is a fundamental philosophy, therefore a naturalistic, holistic study is required, where the goal is to explore and describe rather than to prove or predict.

Theory Base

In the absence of information regarding strategies, interventions, or learning principles for teaching technology-related skills or academic skills to learners with severe or multiple disabilities, research and theory regarding principles of computer-assisted learning for nondisabled students and students with mild disabilities will be examined and applied to learners with severe/profound disabilities. Theories of motivation and self-esteem will be examined for application to learners with significant disabilities.

Problem Statement

This study examines the implementation and use of newly emerging assistive technological tools in the educational program of a student with severe, multiple disabilities. By using qualitative measures of observation, interview, and review of records and documents, it is hoped that valuable insight regarding aspects of teaching and learning strategies will emerge. This study will attempt to provide information regarding the impact of assistive technology use on interpersonal factors such as motivation, behavior, and self-esteem. Additionally, any interrelated effects on the attitudes and expectations of significant others toward the participants will be analyzed. By examining these factors, it is hoped that this study will contribute useful findings regarding the overall impact of assistive technologies on the educational environment and programs of students with severe or multiple disabilities.

Significance of the Study

This is a unique time in history for individuals with significant disabilities. Societal trends, new innovations in technology, and legislative mandates have converged to create unprecedented opportunities for change, growth, and the empowerment of individuals with disabilities. Now there is more potential than ever for providing true assistance in the educational functioning of students who were once considered incapable of learning much. A reasonable prediction, based on the convergence of these trends, is that technology use will continue to expand at a rapid rate in the field of special education, and that the educational functioning of individuals with severe or multiple disabilities will assume an increased reliance on assistive technology.

The significance of this study concerns the educational programs of individuals with severe or multiple disabilities. Educational goals and programming choices are created based on the expectations and attitudes of teachers, parents, and various staff members involved in the child's treatment. Educational goals, particularly for those with severe retardation, have traditionally been limited to the "functional" range, i.e., brushing teeth, doing laundry, assembling bolts, sorting items, etc. (Orelove & Sobsey, 1991; Guess & Helmstetter, 1986). Certain types of educational goals (language skills for a nonverbal student, for example, or painting for a student with limited hand movement) have not been adequately considered for students with severe disabilities, because there has traditionally been no way for those students to perform those tasks. There was no way for the students to practice certain skills, there was no way for teachers to instruct the student, and there was no way to evaluate those skills.

Academic expectations, especially, have traditionally been low or nonexistent for individuals with severe or multiple disabilities (Lewis, 1993). For example, it has been commonly assumed that a student could not be expected to spell, if that student could not verbalize the letters, write the letters, or type the letters. Now, however, new innovations in technology can make each of these things possible. A student can use a device to "speak" letters, or can make use of adaptive hardware that enables the student to practice letter recognition or type letters without traditional keyboarding demands. Improvements in instructional design of software can target the unique cognitive needs of special learners, increasing potential for learning and performance in these areas. Even now, word prediction and grammar-monitoring systems are changing the required set of subskills involved in reading and writing, therefore challenging the traditional definition of literacy.

Technology holds the potential to significantly alter the traditionally accepted boundaries of severe disabilities. As assistive technology becomes more sophisticated, it could be predicted that systems will become more user-friendly and transparent (accessible to those who know little about the systems that drive the technology). As technology-based assistance becomes more and more common, it may become necessary for educators to change their expectations concerning individuals with severe and multiple disabilities (Garner & Campbell, 1987).

As with all new areas of study in education, questions regarding the use of assistive technology increase in correspondence with the general advancement of technology in our society. Information is needed to understand the impact of newly developing technological tools in the educational setting. There is very little information available concerning strategies, best practices, or proposed variables for research, particularly in the area of computer-assisted instruction for students with significant disabilities. Observational studies are needed to examine the impact of technology use by students with severe or multiple disabilities on factors such as achievement, learning, inclusion, social interactions, motivation, behavior, self-esteem, or the attitudes of significant others (teachers, peers, etc.) in the educational setting.

CHAPTER II: REVIEW OF THE LITERATURE

The following review of literature was guided by a desire to address the ways that assistive technology might be affecting the education of individuals with special needs. The purpose of this search was to identify what is already known about technology use in the educational environment of individuals with severe or multiple disabilities. Attention was directed to any evidence involving technology use in areas such as performance, learning, behavior, motivation, self-esteem, social interactions, and educational goals. A search was undertaken for information regarding the potential impact of new tools, and how they might be affecting the attitudes or perceptions of significant others toward students with severe or multiple disabilities.

Technology and Education

In schools, the microcomputer continues to revolutionize education by challenging traditional concepts of teaching and learning. Hundreds of thousands of microcomputers are in schools today. Thousands of studies have been undertaken to study microcomputer use in schools. In general, those studies have shown positive trends in achievement for both nonexceptional and exceptional students. Students of all abilities learn more material in less time when using computers (Hannaford, 1993).

Meta-analyses undertaken in recent years have confirmed positive trends for computer-assisted learning (Lepper & Gurtner, 1989; Condry & Keith, 1983; Burns & Bozeman,1981). Kulik and Kulik (1987) completed an extensive investigation of research findings on computer-assisted instruction, providing a broad overview of research findings to that date. Kulik and Kulik looked at 199 comparative studies of elementary, high school, higher education, and adult education with computers. Using meta-analytic techniques to investigate large numbers of studies, it was found that students generally learned more with computer-based instruction, raising their scores on the average from the 50th to the 61st percentile. Students learned material more quickly when using computers, averaging a 32% reduction in time of instruction.

Student achievement, the overwhelmingly preferred dependent variable in research of this phenomenon to date, has shown a consistent and positive trend toward increased production in both quality and quantity of learning. However, many of the "earlier" studies were contaminated by problems with research design. Unclear definition of independent variable (strategy, software, instructional design), found widely in the research, reflected a basic lack of understanding of the new tools appearing in the field. Early educational software was poorly designed, and measures for standardized methods of delivery were rarely addressed. Software designed by computer engineers and hackers was plagued with poorly sequenced materials, inappropriate reinforcement, or questionable content matter. Compounding those problems, there was very little knowledge of teaching strategies, or how to use the technology as a teaching tool. Given widespread ignorance of how to integrate this new medium, one might consider the consistently positive trends in learning even more impressive.

Dramatic improvements have occurred in the understanding of computer-assisted instruction since the early 1980s. As educators have become more involved in the instructional design of educational software (and in technology in general), a much broader understanding of application has begun to develop. Today the literature base is saturated with articles and studies about technology and education, and the thrust of that research is steadily evolving toward a more and more empirical knowledge base. A steadily increasing amount of information in the form of journals, textbooks, organizations, community inservice opportunities, and teacher preparation materials, contribute to insight into the complexities of educating with technology.

Technology and Special Needs in Education

The use of technology by individuals with disabilities was first recognized in the field of human services in the early 1980s. Johns Hopkins University called for the first national search for applications of computer use with and by the handicapped, and hosted one of the first workshops on this topic in October, 1981 (Lahm & Eltring, 1989). The Council for Exceptional Children followed with the First National Conference on the Use of Microcomputers in Education in March 1983 (Lahm & Eltring, 1989). Since that time, specialized technology applications have continued to grow, and a steadily increasing body of research has continued to evolve. Following trends in society and education as a whole, applications of technology for individuals with significant disabilities are currently in a stage of rapid expansion.

Computer-assisted instruction. As with all students, computer-assisted instruction has been the most common use of technology for individuals with disabilities (Hannaford, 1993). Although nearly all children love computers, the microcomputer as a teaching tool has unique characteristics that seem particularly well suited to address the needs of the exceptional learner. Enhanced graphics and sound provide a medium of stimulating color, action, and sound that is so familiar to today's video/media-saturated children. The interactive format, similar to the wildly popular video game medium, can provide immediate reinforcement or correction in an objective, non-threatening, and non-judgmental manner. Particularly useful are the individualization and self-pacing that are built into most software programs. The microcomputer format provides the avenue for delivery of material via alternate or multiple modalities, i.e., visual, auditory, kinesthetic, interactive, manipulative. These features provide a very effective setting for meeting the needs of exceptional learners, who present a wide variety of special needs and learning styles.

When powerful features of the microcomputer format are combined with well-designed teaching/learning strategies and educationally relevant content, the results are undeniable. For students with mild or moderate disabilities (70% of the total population of students with disabilities), the research findings have been positive and encouraging (Okolo, 1993; Hannaford, 1983; Hasselbring, Goin, & Bransford, 1987). Consistently positive trends have led many professionals in the field to believe that with exceptional students, the power of the microcomputer as an educational tool is perhaps even more promising than with non-exceptional students. Early studies showed computer-assisted instruction to have larger effect with both exceptional learners and younger learners (Condry & Keith, 1983; Jamison & Lovatt, 1983). In studies where written skills improved, low achieving students made the greatest gains (Bangert-Drowns, 1989).

When Hannaford stated, after a 1993 review of literature, that "using computers appears to more easily provide education to students who have typically been difficult to reach and teach", was he suggesting that disabled students learned "more easily" than nondisabled students, or "more easily" than via traditional mediums, as Woodward, Carnine, and Gersten suggested in 1988? Regardless, the effects on achievement and classroom performance point to a very positive trend for exceptional students. When used correctly, computer-assisted instruction has been shown to positively affect achievement scores for exceptional learners in basic skill areas such as math (Okolo, 1992; Bahr & Rieth, 1991; Carmen & Kosberg, 1982), spelling (MacArthur, Haynes, Malouf, Harris, and Owings, 1990), decoding, word identification, and vocabulary (Swan, Guerrero, Mitrani, & Schoener, 1990; Jones, Torgesen, & Sexton, 1987; Saracho, 1982).

Instruction of students with mild disabilities by technology-assisted mediums has shown positive effects in areas that include social studies (Horton, Lovitt, Givens, & Nelson, 1989), math computations (Okolo, 1992), and problem solving (Woodward, Carnine, Gersten, Gleason, Johnson, & Collins, 1986). Written expression skills improve when word processing skills are integrated with instruction in written expression (MacArthur, C., 1998; Cochran-Smith, 1991; Morocco, Dalton, & Tivnan, 1989), with the lower achievers often making the greatest gains (Bangert-Drowns, 1989).

Affective issues. Numerous studies show positive attitudes regarding word processed product (Cochran-Smith, 1991; Morocco, Dalton, and Tivnan, 1989). As with many academic tasks, when the struggling student becomes accustomed to thinking of writing as a "test", one for which he is likely to be corrected, scolded, or punished, motivation for that task is likely to plunge (Thomas, Englert, & Gregg, 1987). Word processing, however, when taught as a write-edit procedure, can eliminate the one-shot "test" fears of many students, changing the way they approach and view the writing task (Cochran-Smith, 1991; Kahn, 1988).

An important key to the ability of the microcomputer to enhance successful learning may lie in its power to motivate the learner. We know from overwhelming and consistent anecdotal information taken from both early studies and continuing studies, that children of all abilities are motivated to use computers. Teachers repeatedly report that students are eager to use computers and view computer use positively (Hannaford, 1993; Okolo, Rieth, & Bahr, 1989; Cosden, 1988; Thormann, Gersten, Moore, & Morvant, 1987). Students themselves express positive attitudes towards computers (Gardner & Bates, 1991; Lepper & Gurtner, 1989; Cosden, 1988). Computer use has been associated with positive attitudes toward both computers and the classes in which they were used (Kulik & Kulik, 1987; Okolo, 1993). A sign of enhanced motivation, students with mild disabilities persevere longer with computer-based activities, as evidenced by increased attention and time on task (Hannaford, 1993; Cosden, Gerber, Semmel, Goldman, & Semmel, 1987; Carmen & Koseberg, 1982).

General increases in intrinsic motivation have been associated with computer-based instruction (Rieber, 1990; Lepper & Malone, 1987; Malouf, 1987). The computer medium has also shown effects on more specific aspects of motivation. Increases in continuing motivation for the learning task (Malouf, 1987), more accurate attributions for successes or failures (Gardner & Bates, 1991; Griswold, 1984), and increased self-efficacy (Graham & Harris, 1989) have been found in recent studies.

Although the research base shows a consistently positive impact on both the achievement and motivation of students with disabilities who use technology and microcomputer-assisted instruction, almost all of those studies focus on learners with mild to moderate disabilities, a group comprised of 70% of all special education students (Office of Special Education Programs, 1990). How, then, can these findings be applied to learners with a severe disability or multiple disabilities? Is the information regarding those students similar to others? What does the research reflect for this very special population?

Technology and Students with Severe or Multiple Disabilities

The use of technology-assisted devices and microcomputers by individuals with severe or multiple disabilities is a field of study that is still in its early stages, (Behrmann, 1989), a fact which can be verified by a comprehensive search of the literature and research into the area. Microcomputers have had limited relevance for students with severe or multiple disabilities, who were not considered, until recent years, appropriate as users of technology-based devices (Brown & Cavalier, 1992; Brown, 1989). Technology was generally reserved for students with no more than one disability (Garner & Campbell, 1987; Behrmann & Lahm, 1984c). For those with limited or uncontrolled movements, microswitches were generally the only method of input available. Assistive technology for individuals with severe or multiple handicaps initially was limited to switch-operated toys, early augmentative communication devices, and the first single-switch, cause-and-effect software programs. Throughout the 1980s there was a steady increase in the number of studies focusing on use of switch-activation for AAC (augmentative or alternative communication), environmental control, or computer-assisted instruction (Brown, 1989; Brown & Cavalier, 1992).

History of computer access. In the early 1980s, the Adaptive Firmware Card (AFC) was introduced as an interface for nontraditional methods of access to computers. The first useful piece of equipment for opening computer access to individuals with severe or multiple disabilities, it was invented by the parent of a disabled child in response to a personal need for computer access.

The Adaptive Firmware Card provided an interface for use of a touch window, expanded or alternative keyboard(s), switches, and scanning on the Apple II (E and GS) line of computers. When used in conjunction with an Echo or similar sound card, it provided synthesized speech feedback, opening new possibilities for computer-based augmentative communication.

For many years, the AFC was the only piece of equipment available that allowed physical or cognitive accommodation for inputting information into a computer. Although somewhat difficult and labor-intensive to program, this device opened the doors to computer use for many individuals who had been previously denied access to technology. This, in turn, began to lead to the development of better software, the ability to interface the user's technology with off-the-shelf software, and interface of multiple uses for computer, such as environmental control or augmentative communication systems.

Most of the research concerning computer use by individuals with significant disabilities throughout the 1980s and early 1990s was based on AFC-supported technology. The AFC, designed to work with the Apple line of computers, was a pre-cursor to the more advanced techniques that have since evolved. "Windows" or icon-based computer desktops now relieve the user of the burden of many of the operational chores that previously had to be initiated via text command or a physical action (such as inserting or removing floppy disks). In general, computers have expanded to include a wider variety of uses and assistance, providing capabilities that benefit users with disabilities, such as text-to-speech feedback. This feature, for example, has broadened the audience of users to include individuals who do not read well, such as those with blindness or severe learning disabilities.

Current trends in computer access. Computers can do more with less adaptive hardware now. Touch windows, expanded keyboards, and single-switch software can now be supported by mainstream computer systems (no hardware peripherals needed), eliminating the confusion of adaptive firmware card and overlay programming. An increasing number of 'regular ed' software programs currently on the market are designed to support switch-and-scanning without the use of an adaptive interface.

Adaptive hardware has also undergone tremendous advances in the past five years. The Ke:Nx system, for example, developed in the early 1990s by Don Johnston, Inc., is a highly improved adaptive interface that is based on a "user friendly" authoring system which can be programmed by professionals who do not possess an intense technical background. With this system, multiple or very specialized input needs can be met with far less labor on the part of the educator or rehabilitation specialist.

Prior to this decade, very few software programs were made for persons with severe and multiple disabilities, and software designed for general populations was not appropriate for students with severe disabilities (Levine, 1986). Performance or cognition demands required to access mainstream software were typically inappropriate for the user with more significant disabilities (Lewis & Doorlag, 1987). Educational software for this special population of students, either public domain or commercially produced, typically centered on very specialized uses, such as switch-training or cause-and-effect training (Lewis, 1990). Typically, this type of software was somewhat ineffective, due to difficulties in 'wait time', immediacy of reinforcement/effect, or inappropriate cognitive requirements. Like switch toys, switch training software was generally based on a repeated motion, sound, or flashing color. Different levels of attention span, distractibility, developmental level, language delay, hearing problems, impaired vision, sequencing ability, visual or auditory motor difficulties, and/or cognitive processing are all factors that may have interfered with a user's ability to scan. These factors, which should have been considered as variables that affected the amount and accuracy of switch activations, were often ignored. Regardless of the reasons, for many years, inaccuracy in switch use was commonly used as a basis for ruling out any attempt to use microcomputers (Lewis & Doorlag, 1987).

Until very recently, few programs focused on the training of skills other than those at a cause-effect level, and almost none on academic skills (Lewis, 1990). Although not properly reflected in the literature base, this situation has changed significantly in recent years. Switch-training software is now more immediate, relevant, and interesting. Graphics, sound, music, and animation are used to provide powerfully reinforcing programs at appropriate cognitive and social levels. A number of language/ communication software systems and language development programs are now available and accessible through alternative input modalities such as switch-activated scanning. Improvements in software design, such as options for "read-aloud" programs or programs with large pictures and uncluttered screens, together with general upgrades in graphics and sound capabilities, have made learning more accessible for almost everyone, targeting for the first time (via options that can be adjusted to "fit" the user) individuals with special cognitive or learning needs. In addition, a number of off-the-shelf educational software packages are accessible via touch windows or built-in switch-and-scanning capabilities.

With improvements in both hardware and software, the computer is simply becoming increasingly more accessible to learners with severe or multiple handicaps (CEC Today, 1996). The ability to use off-the-shelf software has opened new realms of possibility. The ability to configure the computer for multiple uses, such as environmental control or augmentative communication systems, when added to its use as a basic learning tool, has greatly broadened the importance of the microcomputer as a tool for individuals with significant disabilities (Haaf, 1995).

Current Information

What, then, is happening with the use of microcomputers among persons with severe or multiple disabilities? How have microcomputers or other technology-based assistive devices been used by those individuals in educational settings? What has been learned so far? A comprehensive search of the literature related to the use of technology specifically with individuals with severe or multiple disabilities was undertaken, resulting in information on many different and widely variant uses of technology by this special category of students. The issues are difficult to categorize or delineate, being clouded by confusion and lack of information, and many overlapping issues. However, an attempt was made to divide information into several broad domains, each of which will be addressed by a review of literature. These areas include 1) access, 2) operational skills, 3) computer as an assistive tool, 4) computer as a learning tool, and 5) related affective issues.

Access to Technology

For individuals with severe disabilities, access to technology has been very limited until recent years (Church & Glennen, 1992; Brown & Cavalier, 1992). Historically, many individuals with severe or multiple disabilities were unable to operate a computer, because they could not input information or commands via traditional methods such as the keyboard or mouse (Levine, 1986). Gaining access for a user with special needs involves determination of the easiest and most effective way for the user to operate (input/output) a computer or technology-based device, along with identification of any related factors that might influence successful use of that technology. Related factors might include cognitive skills, sensory skills, motor skills, and a myriad of less obvious issues, such as the complexity of the technology itself, the user's operating environment, or the knowledge or experience of the user's support network (Church & Glennen, 1992).

Evaluation. Evaluation of technology needs is mandated by the Technology-Related Assistance for Individuals with Disabilities Act of 1988, (P.L.100-407). Assistive technology evaluations, whether for computer adaptations, augmentative communication, or environmental control, have typically centered on access issues, i.e., positioning, switch type and placement, and recommendation of a device or adaptive system that would best meet the needs of the client. A growing need for proper evaluation of access and positioning has spawned several new evaluative tools, such as the Lifespace Access Profile (Williams, Stemach, Wolfe, & Stanger, 1993) and the

Physical Characteristics Assessment (McGregor, Arango, Fraser, & Kangas, 1994).

Positioning. Positioning refers to the physical placement of the body, with particular attention paid to the movement that will be used to input data into a computer or technology-based tool. Correct positioning has been termed a major influence on the use of the motor skills necessary to access computers, augmentative communication devices, or other assistive technologies (Church & Glennan, 1992; McEwen & Karlan, 1989). In the evaluation process, the positioning expert (usually a Physical or Occupational Therapist), provides information regarding the optimal seating position for an individual at a computer or workstation. Stability, support, proper postural alignment, and comfort are factors that must be considered (Harrymann & Warren, 1992). Additionally, physical requirements of the proposed technological device must be considered in relationship to the client's abilities. In individuals with severe disabilities, there may be problems with voluntary movement, alterations in muscle tone, orthopedic problems, or other neuromuscular involvements. The individual's physical ability to input information to a computer or AAC device must be assessed, and recommendations for any required adaptations examined. If switches or scanning techniques are necessary, proper positioning of the hand, head or accessing body part must be matched to requirements of the device. In this area, there is little empirical or experimental research regarding the effectiveness of various positions as applied to the use of technological devices.

One outstanding exception is a study that looked at effects of various positions on communication board access. McEwen and Karlan (1989) used an alternating treatments design to compare the effect of different positions (chair, stander, pronewedge, and sidelyer) on latency of response in switch activation. Two subjects, preschool students with quadriplegic cerebral palsy, showed significantly more latency in the sidelying position, with only minimal differences in the other three positions. This study is one of only a few that provides empirical evidence concerning the effects of positioning on adaptive devices. The intra-subject comparison across conditions served as a control for any intervening variables such as motivation, instructional design of software, etc. With this study, McEwen & Karlan have provided a model of assessment for positioning and access in the use of assistive devices.

Switch access. Switch access is an essential component of any augmentative communication or assistive technology evaluation, and is an especially critical need for individuals with physical limitations which interfere with computer input. Activation of switches, however, is a necessary pre-cursor for any and every individual who uses a computer or computer-interfaced technology. Any use of these devices must be preceded by the ability to purposefully, consistently, and accurately close/open a switch. Traditionally, individuals close and open dozens of switches on their computer (by pressing keys or 'clicking' the mouse) to input and execute a variety of commands that instruct the computer to perform various tasks.

Individuals limited in finger dexterity, range of motion, or motor control, however, must often rely on specialized input methods that present "menus" or choices which scan by the user's field of vision on the computer screen. When the correct answer arrives, the switch is activated and that command, whether it's a letter to be typed or a special infrared-linked command to "turn on the lights", is executed independently by the user.

Adaptive hardware systems interface with switches to provide hundreds of different ways for individuals to input virtually any letter, word, or command to the computer. With hundreds of different types of switches now on the market, this procedure, via use of any consistent movement, such as an eye blink, a puff of air, or a small switch attached to knee, chin, or little finger empowers almost any individual with the use of the microcomputer. Persons with severe limitations in physical ability, such as palsied extremities or paralysis of limbs, can now fully use a computer or other technology-based devices in their homes, schools, or jobs.

Device recommendation. Earlier theories of "cognitive prerequisites" or "candidacy potential", a direct result of the limited amount and type of technology available, were necessary because the technology was at best inconsistent, difficult to operate, produced a poor quality of voices or graphics, and required immense powers of concentration and patience to operate.

As technology options began to expand, many different types of AAC devices and computer adaptations began to appear. Still, though, the evaluation and recommendation process was limited to existing technologies, often relying on the "feature match" theory. This theory is based on a comparison of the features (needs) of the child with the features of all of the available or known devices on the market. The evaluator then makes the best "match" possible. With this concept, the needs of the user are strongly influenced by the parameters of the examiner's knowledge, as well as the actual state of the art of the technology available on the market (Grady, Kovach, Lange, & Shannon, 1991). Gradually, this type of candidacy model is being replaced by more client-centered approaches, such as the Communication Participation Model (Beukelman & Mirenda, 1992), which looks at assessment as an ongoing process, or Karlan's (1993) Environmental Communication Teaching model, which focuses on a variety of strategies to teach communication rather than the correct selection of a device.

Access-based "candidacy" requirements, once necessary because of the limitations of the equipment, are gradually being replaced by more learner-centered concerns. However, this gradual shift away from the focus on prerequisites has not come about quickly or easily. The research base tells the story. Access, almost singularly, has been the primary need, the major preoccupation of the field, and the main focus of the information base until recent years. The literature has focused on information concerning access to computer, i.e., positioning, evaluations, and switches, device features, etc.— how to get access established, as opposed to what is being done with the computer once access has been successfully resolved.

Operational Skills for the User

The concept of operational skills concerns the area of learning how to operate the machine, the adaptives, the specialized system, or the software application itself. This area includes switch/scanning training and use, as well as basic computer operation skills. From a historical framework, the training of individuals in the use of switches and switch-based scanning has been plagued with difficulties. Limited understanding of the needs of the user, limitations of technology (limited memory, graphics, etc.), slow development in the area of technology and disabilities, and low expectations for disabled users have all contributed to the lack of appropriate technological systems. Switch-training software has been boring, repetitive, and very slow to respond to the switch activation. Prior to recent technological advances (pre-mouse, pre-desktop icons), computer software in general was much more limited. Graphics and sound were poorly representative of targeted reproductions. Speech feedback was robotic and often difficult to understand. Switch toys were, (and in many cases are still) boring and repetitive. These inadequacies may have increased difficulties in initial learning and/or generalization from the learning environment to the field.

Almost surprisingly, given the problems involved, students with disabilities have reportedly been successfully trained to purposefully use switches in many ways. Switch training has promoted the accurately-timed activation of a switch to provide changes in the environment (music, fan, toys), to provide social interaction (calling for an attention), or to make a request ("I want juice, please"). Children have used switches for purposes that include prompting household chores (Lancioni & Oliva, 1988), learning to discriminate between nutritional food groups (Katz, Johnson, & Dalby, 1981), and learning vocal imitation (Tashjian, 1984). Many studies have verified that individuals with significant disabilities can activate switches to communicate preferences and make choices (Rowland & Schweigert, 1991; Dattilo, 1986; York, J., Nietupski, J., & Hamre-Nietupski, S., 1985; Hagen, 1984). More recently, Cook and Calvalier (1999) reported use of switches by a toddler with developmental delay and quadriplegic athetoid cerebral palsy, who was able to use switches to activate a robotic arm to manipulate objects and to retrieve objects for play.

Einis & Bailey (1990) reported on a 25-year old woman who was able to use switches to communicate and control devices in her environment. She was able to increase her vocabulary use from 16 pictures and "yes/no" to a 250-picture system via augmentative communication.

Douglas and Ryan (1988) presented a case study of a 3-year old boy with severe disabilities, who developed the ability to use switches for a variety of causes, such as operating a wheelchair and controlling objects in the environment. The authors of this study point out that switch use, by itself, does not facilitate educational learning. However, they believed that the computer with appropriate software could promote cognitive development. Douglas and Ryan promoted the idea that computer use, as opposed to computer access, might decrease chances of 'learned helplessness' and possible misinterpretations of cognitive abilities.

Switches can now be used to access computer-assisted instruction, augmentative control, movement of a wheelchair, or environmental controls. Switch use by itself, however, as Douglas and Ryan pointed out, does not facilitate educational learning. "Access" also does not, by itself, teach operational skills (such as raising or lowering the volume or opening a file), skills specific to adaptive hardware (which switch position for Ke:Nx, for example), or skills specific to operation of specialized software (such as changing keyboard overlay setups). Students with multiple disabilities may require even more specialized instruction at the computer, as they must learn the additional skills involved in operating adaptive hardware or assistive software systems.

Before an individual can successfully use technology to perform tasks such as speaking, walking, or controlling the environment, he/she must learn how to operate the software and systems that drive the devices. Before an individual can use a computer to learn curriculum, basic skills, language, or vocational training concepts, he or she must learn to operate the machine and the software. Before a user can tell his computer to turn on the lights, drive the wheelchair forward, or verbally answer a question, he must be able to operate the software systems that allow the computer to perform these tasks. A user may need to learn how the special "read-aloud" word processing package operates, how to use a spell checker, or how to use word prediction software. Each of these skills have to be learned by the user with severe or multiple disabilities. Switch-and-scanning, touch window use, adapted mouses, auditory access--each have unique skill requirements that must be learned as a prerequisite to effective computer use.

With the exception of switch training, there appears to be very little research available to guide educators in their attempts to teach operational skills to users of computers with adaptive systems. The idea of teaching a student with severe or profound disabilities to operate a computer for something other than cause-and-effect has not yet been addressed to any extent in the existing literature. Given the emergence of easier, more "user-friendly" systems on the current market, it would follow that this area of study would present a pressing concern in the profession of special education.

Uses of Technology

The previous discussion leads to a very important point--the difference between technology access and technology use. As noted previously, computer access must be determined through a careful and comprehensive evaluative process. Students must be trained to use special software and/or hardware systems. However, once access methods have been determined and resolved, how is the technology being used?

After separating out the issue of learning/training of operational skills, computer and technology use falls into two major categories: 1) the use of technology as an assistive tool, i.e., a prosthetic, assistive, or compensatory device that performs a necessary life function, such as speaking, walking, or writing; and 2) the use of the technology for learning or acquiring new information or skills.

Technology as an assistive tool. Computers have been used to act as prosthetic devices (Locke & Mirenda, 1988; Stallard, 1982), providing assistance or compensation for those physical tasks that are made more difficult or impossible by certain types of disabilities. As a prosthesis, computers can be used to supply the means for communication, mobility, or environmental control. Additionally, technology-based devices can be used to provide auditory or visual assistance, such as FM or amplification systems, text-enlargement, or other auditory-based systems for those with visual limitations. Under discussion for the future are voice-activated systems (Cavalier & Brown, 1998), robotic assistants, "smart" prosthetic limbs, biological computers, and artificial intelligence via cognitive prostheses (Hannaford, 1993). Applications of virtual reality for users with severe disabilities may soon include sensory experiences, like swimming or running, exploration of the environment or the world, and simulated training for powered mobility or job skills (Ira, 1997). Current uses of technology as an assistive tool, however, focus on areas of augmentative communication, environmental control, or powered mobility.

Augmentative communication is a primary assistive use of technology for individuals with severe communication disorders, especially those who are non-verbal or whose speech is unintelligible. Use of technology as a voice prosthesis for individuals with severe or profound disabilities has assumed an increasingly important role in the profession of speech/language therapy.

Many case studies have been undertaken which describe use of early adaptive hardware for purposes of facilitating communication. Locke &

Mirenda (1988), for example, reported on the successful use of a microcomputer using synthesized speech by an 11-year old non-speaking student with severe cognitive and visual impairments. Using textured symbols and a Unicorn keyboard, the child was able to acquire purposeful use of six short phrases. Romski, Sevcik, & Washburn (1987), reported successful use of another device, the PortableVoiceII, interfaced with the Unicorn keyboard in teaching thirteen students with severe retardation to use basic expressions of need and preference.

McGregor, Young, Gerak, Thomas, & Vogelsberg (1992) used an intervention package to increase the functionality of a communication device, the Touch Talker, used by a 20-year old student with severe disabilities in a job-training setting. The intervention consisted of training by direct modeling, instruction, and corrective feedback or reinforcement, combined with strategies in the natural environment such as prompting and verbal reinforcement. This well-designed ABA (multiple baseline across settings) study showed a clear functional relationship between the intervention and targeted communication goals. The student was able to replace nonfunctional communicative behaviors, such as loud and disruptive vocalizations or work stoppage, with a series of work-related phrases such as "something's wrong", or "I want a break". This study demonstrates the importance of the role of training strategies in facilitating the use of augmented communication.

A case study provided by Glennen, Sharp-Bittner, & Tullos (1991), looked at changes in a 36-year old subject of normal cognition, who had lost his voice due to paralysis of facial and laryngeal muscles two years previous to the study. A comparison was made of the effectiveness of spelling with an augmentative communication device (Touch Talker), coded symbol sequences with the same device, and use of gestures (no device). It was found that coded symbol sequences became the preferred method of communication, replacing letter spelling as training was provided to increase memorization of the sequences. Conclusions from this insightful study included 1) extensive training is needed to teach non-speaking persons to use augmentative communication devices, 2) several revisions of the system may be required to develop a working communication system, and 3) the use of previously stored phrases will facilitate communication in users of normal cognition.

Although much of our understanding of the field of augmentative communication is still in an early stage of development, there is an enormous amount of consumer information about various devices and their characteristics. Price, weight, memory limitations, and other features are readily available in a skyrocketing expansion of the knowledge base for this area. Resource information, manufacturer listings, directories, networks, data bases, and bulletin board services abound. Empirical research to compare the effects of different features, intervention strategies, or training procedures, however, is still very limited. Knowledge to date of the effects of specific features related to communication devices, such as choice and arrangement of symbol sets, output modes, selection techniques, or retrieval strategies, is very limited (Romski & Sevcik, 1988). The importance of those variables cannot be discounted. For example, the type of output mode (print, synthesized speech, digitized speech, or liquid crystal display) can affect listeners' feelings and attitudes toward users (Coxson & Mathy-Laikko, 1983; Light, 1988). Intelligibility of the output voice can dramatically affect the user's ability to communicate. Venkatagiri (1991) found that listener comprehension of synthesized speech with the Echo II could be significantly improved by varying the rate and pitch of the voice output. A recent comparison of voices in existing communication software systems found newly marketed voice synthesis systems (MacinTalk Pro) significantly more comprehensible than those previously considered status quo (Rupprecht, Beukelman, & Vrtiska, 1995).

Environmental control, a second important assistive use of technology, generally refers to the ability of a user to activate a switch to control an appliance, temperature, lights, or other devices in the environment. The ability to control one's environment with some degree of independence and autonomy is a crucial need for individuals with severe physical limitations. Systems may take the form of computer interface, switches hooked up to environmental control units, electromagnetic spectrums (infrared control, radio control, ultrasound control), or AC power line controls (Church & Glennan, 1992). Environmental control is a somewhat nebulous concept that could include, in addition to the operation of appliances and utilities, the ability to explore and manipulate the environment via switch toys (Burkhart, 1982), the ability to make choices (Cavalier & Brown, 1998; Locke & Mirenda, 1988; Behrmann & Lahm, 1984a; 1984b), and the promotion of independence in severely impaired individuals (Esposito, 1993, Kristiansen, 1988).

Absence of control has been associated with many disabling conditions, including depression (Seligman, 1975), motivational problems (Weiner, 1979), and deteriorating health (Glass, 1977; Rodin & Langer, 1977). Although research on the use of these devices appears to be very limited, the impact on quality of life for a physically disabled individual who becomes able to control the temperature, lights, telephone, television, or other appliances in the home environment seems obvious.

Brown & Cavalier (1992) were successful in teaching a 41-year old female, described as profoundly retarded, non-ambulatory, quadriplegic, and unintelligible to use voice input to control devices in her environment. After observation determined a limited number of stable vocalizations, the authors used a multiple-baseline-across behaviors design to measure contingency response to four highly reinforcing activities that were tied to specified target vocalizations. After a period of shaping and reinforcement, the subject clearly learned to discriminate between words and their linked meaning. She also showed purposeful and increasing use of the word "off" to activate a more generalized operational command.

Robotics hold great promise for those unable to control the environment through conventional methods. In a 1989 study by Richard Howell, students with severe orthopedic disabilities, who had little to no experience with purposeful manipulation of objects, were able to use robotic arms to pick up, manipulate, and place objects through use of computer-interface with a switch-and-scanning device. Cook & Cavalier (1999) reported on successful training of a very young child with a severe developmental disability to use a robotic arm for discovery and play. Unlike many of its predecessors, this study provided a thorough operalization of a training sequence for teaching the child various processes involved in the effective use of the technology.

Powered mobility, another use of technology as a prosthetic/assistive tool, is the use of computer or technology-interfaced systems to provide powered wheelchairs, scooters, or other assistance for individuals whose ability to walk is impaired. Children as young as 18-24 months who have severe physical disabilities have been able to effectively use a powered wheelchair with a joystick (Trefler, Kozole, & Snell, 1986; Butler, Okamoto, & McKey, 1983). Powered mobility has shown positive effects on developmental skills (Hays, 1987; Snell & Balfour, 1987), self-esteem, motivation, and autonomy (Butler, et al., 1983; Paulson & Christofferson, 1984).

Computer-assisted learning. As with all school children, individuals with severe or multiple disabilities should be able to participate in computer-assisted learning activities that are relevant, challenging, cognitively appropriate, and age-appropriate, for purposes of direct instruction or training. For individuals who have been limited in their ability to benefit from traditional types of instruction, learning via computer could possibly be the most important area of concern in their educational program. Opportunities for repeated practice in a learning environment that is private, patient, non-threatening, and multi-modal could arguably be considered a basic educational need for students with limited learning opportunities.

Rather than using computers to teach basic concepts such as counting, colors, size, or other commonly recommended early learning curricula, switch training activities have centered on use of the computer for more "functional" reasons. Young children with severe disabilities have been reported to use computers to manipulate contingencies (Sullivan & Lewis, 1988; 1990; Butler, 1988; Brinker & Lewis, 1982), to make choices concerning activities or desired objects (Locke & Mirenda, 1988; Behrmann & Lahm, 1984a; 1984b), to interact socially (Podmore & Craig, 1989; Spiegel-McGill, Zippiroli, & Mistrett, 1989), to operate devices in their environment to communicate (Herman & Herman 1989; Hutinger, 1986a; 1986b; Meyers, 1984; 1990; Muhlstein & Croft, 1986; Shane & Anastasio, 1989; Spiegel-McGill et al., 1989), to develop a sense of control over their environment (Hutinger, 1988), for recreation (Sedlak, Doyle, & Schloss, 1982), and to solve problems (Cook & Cavalier, 1999; Hutinger 1987b; Wright & Samaras, 1986).

Upon closer examination of these and other early studies, however, one finds that switch training has commonly been paired with outcomes assumed to be reinforcing or entertaining for the user, such as watching random lights or tones, or perhaps static, repetitive "switch-toy" portrayals, such as the never-ending drumming bear, a spider climbing up and down a ladder, or a snatch of music. The number of switch activations in this type of activity has been commonly used to measure whether the user is developing a sense of control, operating contingencies, or having a recreational experience. Factors not taken into account might include the user's interest, relevance of the materials, level of boredom, or the level of challenge or control presented within the activity.

Dura, Mulick, Hammer, and Myers (1990) presented an interesting study of microcomputer use for people with multiple handicaps, profound mental retardation, and history of learning failure. This project, while focused on establishing independent or spontaneous interaction with the microcomputer, is illustrative of the difficulties of researching when equipment limitations define the variable. The authors, in reaction to a failure to increase successful and independent usage of microcomputers, hypothesized that the traditional training method, which was described as verbal instruction, manual guidance, and social praise, was in competition with reinforcement delivered via computer. It was noted that students without fail would orient toward the adult (as opposed to the computer) to see if they had succeeded (via social praise or correction). Each of the four students involved had multiple physical handicaps and profound mental retardation. They had already been successful in activating a joystick on Apple IIE computers. In an attempt to increase independent interaction with microcomputer, a stimulus-reduced environment was provided. Students were placed in quiet, darkened areas. Each was provided a computer with cause-and-effect software, which provided random color and tone when activated. After a prompting phase, independent activation was measured for a period of two sessions, followed by an extinction phase, where the computer did not respond to activation attempts. While this multiple baseline, across-subjects study was methodologically sound, results showed clearly that the attention of the attending adults was more reinforcing than the cause-and-effect software, which provided 'random color and tone' when activated. Two of the students showed strong learning following the prompting phase, and dropped response during extinction. Two students showed no learning during either the prompting or no prompting conditions. The authors point out that the study was limited by unknown variables (perhaps the training length was not appropriate, perhaps the software was not reinforcing and the students just didn't like it). One would suspect that any human being would soon find the infinitely changing reactions of other humans preferable to a random presentation of differently colored screens. The real strength of this study is that it is one of only a few that look at strategies or training needs that related the computer-assisted format, and the variables that may affect learning for students with multiple or severe disabilities. This study illustrates that traditional teaching methods may not always be appropriate for training students with severe and profound disabilities to use the computer. It also points out the difficulties that have been inherent in the early evolving field of microcomputer use with individuals with significant difficulties. The software, among other things, just wasn't very motivating.

Clearly, very few studies in the history of this field have centered on academic achievements, curricular-based goals, or computer-skill training, with the exception of switch-training activities. Scholarly investigation focusing on the effects of computer-assisted learning on the performance of curricular skills does not appear to have been addressed for this population.

Multiple Use Case Studies

Driven by advances in technology, computers, which are growing in capacity and shrinking in size, have begun to perform for the user in many more flexible and powerful ways. Microcomputers are now able to supersede the earlier (non-computer-interfaced) augmentative communication and environmental control systems, providing "smarter" tools for an ever-broadening variety of assistance. As today's technology becomes more and more capable of providing one single control center for all types of assistance, there are many issues that begin to merge.

The areas of computer-assisted learning, augmentative communication, and environmental control have begun to overlap and become indistinguishable as individuals begin using one off-the-shelf computer for assistance in each of these areas. Today's microcomputers are able to provide assistance to a single user with a variety of needs. For example, one microcomputer can now be used as an augmentative communication device, an environmental control system, an instructional tool, a recreational device, a vocational tool, and/or a social/recreational outlet. Case studies where computers provide the interface for multi-categorical uses of assistive technology may be helpful in broadening our understanding of this rapidly developing field.

Hutinger, Johanson, and Stoneburner (1996) presented a case study report on a 3-year project examining the use of assistive technology with fourteen young children with severe disabilities. Classic qualitative methods (observation, interview, and historical information search) were used to collect data for this series of case studies. This study presented a great deal of information about staff training and parental attitudes in addition to direct impact on the children involved. Major themes surrounded the impact and purpose of assistive technology use, educational placements and transitions, patterns of use, and the acquisition and maintenance of the equipment. Challenges and critical supports for technology use were discussed. This study, although reporting a positive impact on various measures, such as activation, communication, accomplishment of new tasks, and social and emotional gains, reported a disturbing number of barriers to successful, long range use of the equipment. Planning, staff training, lack of smooth transition in placement moves, and a lack of integration of the technology into teaching plans and curriculum were discussed, concluding that "major changes in the technology practices of staff and administrators are needed if the schools are to make use of the potential of technology for children with disabilities" (p. 33). The stated goals of the study, i.e., describing the use and effects of assistive technology, analyzing the benefits and barriers, and determining the implication of the findings were effectively met in this well-written, interesting, and thorough report.

Bonnie Todis and Hill Walker (1993) provide a valuable two year qualitative study of issues associated with assistive technology in the educational setting. This well-designed qualitative study clearly addresses design, data collection, and analysis methods. The authors provide contextualized descriptions of two severely disabled subjects and their use of individually tailored assistive technology in the educational setting. These subjects were chosen as representative of those participating in a two-year study of thirteen students with a "variety of disabling conditions and ...an array of assistive technology". Themes that emerge from the study include issues surrounding evaluation, funding and acquisition, training, daily use, demands on school personnel, and interaction of factors. Recommendations, such as "reevaluate frequently" are clearly generated in an inductive manner. After discussing the problems encountered with the use of assistive technology in the school setting, the authors conclude that fragmentation of problem attributions is counterproductive. Systematic observations show that all of the problems occur at times, in a range of intensity. The authors conclude that it is an interrelation of factors that is important. To successfully use assistive technology, it is recommended that professionals "acknowledge the complexity and interaction of the issues relating to [assistive technology]" (p. 15), and consider the impact of values and perspectives of the user, parent, classmate, and all those who work with the user.

Although case studies are essential to the growth of professional knowledge in this field, those that involve longer periods of time may be inhibitory. The technologies are changing so rapidly that it is difficult to bridge the gap between research and relevant practices, and those studies that involve two or more years may result in research and scholarly publications that are not useful because of the 'antiquity' of the technologies being described. In the Hutinger, et.al. (1996) study, for example, much the technology described--Apple GS computers, Adaptive Firmware cards, Echo speech synthesizers--has already been replaced on the market with significantly improved equipment.

Affective Issues

There appears to be very little information regarding the impact of technology use on curricular achievement for users with severe or multiple disabilities. The existing information focuses on access and, to some degree, the operational skills involved in adaptive access. However, as with their nondisabled counterparts, there is a rapidly growing amount of information regarding affective issues that surround the use of technology and computers by individuals with disabilities.

Unlike early warnings that microcomputer use would further isolate individuals, many are now finding that the use of computers can promote social interaction (Hannaford, 1993; Spiegel-McGill, Zippiroli, & Mistrett, 1989). Among the many interesting findings is the idea that the use of computers has been associated with increased communication and interaction with peers (Carey & Sale, 1994; Grady & Timms, 1991; Campbell & Fein, 1986). Many studies have noted an increase in positive behaviors during computer use. Studies have found that students with disabilities demonstrated longer periods of attention and tended to display fewer negative behaviors (Hutinger, 1993; Cosden, Gerber, Semmel, Goldman, & Semmel, 1987; Fick, Fitzgerald, & Milich, 1984; Plienis & Romanczyk, 1982; Carmen & Kosberg, 1982) while working at the computer. Increases in cooperative behavior have also been noted (Campbell & Fein, 1986; Fick, et al., 1984). Additionally, increases in targeted off-computer behaviors have increased when time on computer has been used as a contingency reinforcer (Cheney, 1990; White & Layne, 1987; Salend & Santora, 1985; Buckalew & Buckalew, 1983). For students with mild or moderate disabilities, the computer-based medium has been associated with more accurate attributions for successes or failures (Gardner & Bates, 1991; Griswold, 1984), and increased self-efficacy (Graham & Harris, 1989).

Low motivation and poor self esteem are often seen among students whose performances are not perceived to be on par with same age peers (Stipek, 1988). A history of failure to perform tasks similar to same age peers may adversely affect the child's self confidence, intrinsic motivation, and judgments about their own abilities (Okolo, 1993; Schunk, 1989). In children with more significant disabilities, the problem often becomes more severe. Learned helplessness, a maladaptive behavior associated with perceived lack of control in an individual's environment, is common among children who believe that they cannot avoid failure and attribute their failures to inferior abilities (Stipek, 1988).

It has been speculated that the overriding reason for the popularity of computer or video games is the powerful sense of control gained by the user (Malone & Lepper, 1987). The amount of control a learner experiences is dictated by the range of outcomes provided and the extent to which each outcome is contingent upon or influenced by the responses of the user. When response time is more immediate (the character moves more quickly in response to the student's input), the learner has exerted a larger amount of control over the learning environment.

It is well-known that humans are most likely to approach or persist at a task that offers high levels of control and autonomy (Stipek, 1988; Malone &

Lepper, 1987; Goldenberg, 1984). This concept might be applied to the use of the computer-assisted medium by individuals with severe and multiple disabilities, who often have been significantly restricted in areas of personal control, autonomy, and independence. One might speculate that the feelings of control provided by well-designed software might be intrinsically motivating to the such a user. Perhaps, with the advent of increasingly better design in switch-operated software, and increasing options for switch-access in off-the-shelf software, the educational programs of individuals with severe or multiple disabilities may be enhanced beyond what was once thought possible. There has simply been no empirical research yet regarding technology and its effects on motivation or self-esteem in individuals with severe or multiple disabilities.

In closing, one cannot look at the impact on an educational environment without including the expectations and perceptions of the capabilities of individuals with significant disabilities by those educators and individuals who will have a tremendous influence on the students' educational program. For those students who have limited influence over their own environment, and for whom most decisions are made by teacher or other staff members, this would seem doubly important.

It is widely recognized that teachers' expectations have a significant effect on student performances (Good, 1987; Rosenthal and Jacobson, 1968). Teachers interact with students in different ways, based on their expectations, and educational goals are influenced by expectations (Linehan, Brady, and Hwang, 1991; Voeltz, Evans, Freedland, & Donellon, 1982).

Even though it would seem that teacher expectations might be considered an even greater concern for students with significant disabilities, there is very limited amount of information concerning this matter. In 1984, Bates, Morrow, Pancsofar, & Sedlak found that college students who watched a portrayal of a student with disabilities engaged in functional activities resulted in higher expectations than those engaged in nonfunctional activities. Linehan, Brady, and Hwang (1991) found that the type of assessment report read by teachers (prior to observing the student) had a significant effect on expectations. Studies by Bayley (1989) and Sullivan and Lewis (1988; 1990) provided anecdotal information concerning the change in perceptions and attitudes of parents toward their severely or multiply disabled children. Cavalier & Cook (1998) reported changes in the attitudes and expectations of caregivers for a woman with severely restricting disabilities, after she learned to choose reinforcers via a voice recognition system. Sullivan and Lewis (1990) emphasize the importance of the potential impact of assistive technology by quoting the parent of a Down syndrome infant in their study. "When they told me my baby would be retarded, I thought that he couldn't learn -- but he can learn. I see that he can learn. Knowing that has made a difference for me." (p. 374). This powerful concept was confirmed by House Committee reports indicating that access to assistive technology has resulted in, among other things, a change in perceptions of the child held by the family and significant others (US House Committee Report 198, 1991). Interviews with parents involved in the Hutinger project (1993) also indicated, among other things, that parents reported a better understanding of their childrens' abilities, and increased expectations for the child's schooling and general participation in life activities.

Unfortunately, articles or information concerning the effects of technology on the expectations of significant others for individuals with severe or multiple disabilities, outside of opinion and anecdotal information, was not found. There is a disturbing gap in published information concerning implementation procedures, instructional strategies, or effects of technology use in areas of performance or achievement. Because there has been very little in the way of formulation or delineation of research variables, informational studies are needed to begin to understand the impact of technology use by students with significant disabilities in the overall educational environment, as well as more specific areas such as motivation, behavior, social interactions, participation, self-esteem, and expectations of significant others.

SYNTHESIS

Knowledge about independent uses of technology for individuals with severe or multiple disabilities, although developing rapidly, is still somewhat limited. Relatively speaking, there has been very little research concerning the impact of this powerful phenomenon related to the education of students with severe or multiple disabilities. Although there is a great deal of technical information and anecdotal information available, very little experimental research is reflected in the literature at this date (Okolo, Bahr, & Rieth, 1993).

The research has often focused on <u>access</u> to computers--positioning, evaluation, different devices and strategies for adapting computers. Technical manuals, resource guides, informational articles, and "how-to" information of all kinds are readily available. Use of computers and technology as an assistive or compensatory tool has concerned another large portion of this work. Information about augmentative communication, environmental control, or accommodation for visual or auditory deficits is expanding at an unprecedented rate, with most of the articles focusing again on "how-to" information or on the training of operational skills.

Unlike with the larger population of students whose disabilities are considered "mild" or "moderate", there are few studies that focus on the relationship between technology and achievement or academic production of the user with significant disabilities. With the exception of switch training and a burgeoning amount of augmentative communication articles, very little information is available in the area of computer use. Information on instruction or training issues was practically non-existent. Even though both non-disabled students and mild/moderately disabled learners were found to be able to learn more efficiently and effectively with computer-based instruction, there appears to have been no documented attempts to create the same results for learner with more significant disabilities. Perhaps those students could also learn more and learn more efficiently via computer-assisted instruction. Perhaps new technological tools could increase a child's ability to participate in traditional curricular goals, such as reading and writing. It is simply not known.

In the past decade, thousands of assistive devices--some based on computer chip technology, others on more simple uses of technology--have flooded the market. This emerging field has been experiencing an information explosion. The literature base throughout this decade has been replete with resource information concerning products--descriptive summaries, directories, resource lists. When one looks past the technical information, anecdotal and opinion pieces comprise most of the existing literature, with more and more case studies appearing. Access issues and prosthetic uses appear to be the main topic for a rapidly increasing body of observational, qualitative case studies. There is very little information available regarding computer-assisted instruction for individuals with severe or multiple disabilities.

It would seem that the field is still in a stage of collecting observational information to allow definition of variables (Okolo, Bahr, and Rieth, 1993), and that an "expansion of the knowledge base" (Beukelman, 1993, p. 63) is occurring, where themes and hypotheses are beginning to develop and variables are beginning to be explored. A huge gap between research and practice has developed in this field, with practice and implementation preceding any valid form of research base. Newly emerging products and technological innovations are appearing rapidly in the marketplace.

Information concerning the implementation and uses of those products, however, is sketchy at best. Ideas for teaching strategies and best practices are desperately needed in classrooms today. The potential of technology for redefining the boundaries of various disabilities and the resulting impact on the educational environment have not been addressed in any significant way. Because of the critical need for information, this study will examine the educational setting, looking specifically at the impact of technology on achievement and other issues, on teaching and learning strategies, and on the attitudes and expectations of significant others in the education of students with severe or multiple disabilities.

CHAPTER III: METHODOLOGY

A comprehensive review of literature found little available information concerning instructional applications or strategies related to technology-based interventions for individuals with severe or multiple disabilities in the educational setting. Given the emerging nature of this field of practice, the lack of available scholarly information, and the individualistic nature of the subjects and setting, a naturalistic method of study was determined to be the only viable methodology for this study. Qualitative methods are commonly considered most appropriate when studying new phenomena in a given field, in order to provide the necessary 'raw material' to define important variables, develop themes, or generate hypotheses (Borg & Gall, 1989) surrounding the issues. In the case of assistive technologies, particularly in the special sub-area of teaching individuals with severe or multiple disabilities to use technology-based tools, so little is yet known that a naturalistic, observational study is clearly a necessary step in the evolution of scholarly research and theory development.

A case study format was used to provide a detailed analysis of one subject, a student with severe and multiple disabilities, and his use of technology for assistive and educational purposes. The subject was selected from a population of students identified as those with severe or multiple disabilities attending a mid-sized suburban school district. A male, elementary-age student with orthopedic impairment and mental retardation was purposefully selected to represent specific characteristics unique to technology access in the educational setting. The subject experienced access barriers to computer use, being unable to accurately control a mouse, touch window, or expanded keyboard, and had special positioning concerns. The subject has repeatedly exhibited behavior difficulties in performance of computer-based activities. Although willing to use simple, low-tech materials and equipment, he has consistently refused to learn operational skills associated with the use of more sophisticated augmentative communication devices and various adaptive computer access equipments. A more detailed description will follow in Chapter Four.

Design

The purpose of the observational case study is to describe or illustrate, not to prove or predict (Bogdan & Biklen, 1982). Case study inquiries are often used when asking "how" or "why" questions about a specific set of events in a real-life context, particularly when there can be little or no experimental control over those events (Yin, 1994). When the boundaries between occurrences and context are unclear and there are a large number of variables to be considered, the case study format may be the most appropriate tool for research (Yin, 1994). Using this format, tentative propositions can be established which can then be verified or discounted by multiple sources of triangulated evidence.

In this study, the subject is a student with severe and multiple disabilities. Severe limitations in his ability to walk, talk, write, or move, make him a prime candidate for assistive technology. The participant was purposefully chosen as one with both technology-based variables (access disabilities) and affective/instructional variables (behavior and motivation). Although he seems to be capable of using technology-based devices to accommodate those disabilities, he is often uncooperative and rejects opportunities to learn to use all but the most simple devices.

Robert Yin presents strong rationale for three instances when selecting single-case design is most appropriate. In his seminal work Case Study Research: Design and Methods (1994), he describes the extreme or unique case, the critical case, and the revelatory case as the major reasons indicating single case design. The **revelatory case** is described as one that "exists when an investigator has an opportunity to observe and analyze a phenomenon previously inaccessible to scientific investigation" (Yin, 1994, p. 40). Although there were a number of "foreshadowed" propositions in the research questions of this study, it seemed likely that much of the data generated could be considered "revelatory" or "exploratory", because of the emerging nature of the technology in use, and the unexplored territory of teaching the student to use the devices. The subject was working with tools that had previously been unavailable, those that created a pathway to the development of skills previously missing from his repertoire of abilities. This unique convergence of phenomenon created the opportunity for studying an area of education that was previously inaccessible to investigation. Therefore, a naturalistic, descriptive, single case study was chosen.

In this study, the opportunity existed for combining elements of rationale from both the the case study and the purely ethnographic study. Combining the two, a microethnographical approach to a case study format was used. Microethnography refers to case studies that are done on a very small part of an organization or on a very specific activity (Bogdan & Biklen, 1982). A slice of the current educational environment, focused on a specific phenomena and the events that surrounded it, i.e., technology use, richly described in a naturalistic format, was used to provide context and perspective for this work. Using a microethnological approach, the study focused on technology/computer-based learning activities for public school students with severe or multiple disabilities.

It is important to note that naturalistic methodology is generative and inductive (Goetz & LeCompt, 1984), beginning with data collection, and building themes and patterns from relationships discovered in the data, as categories, consistencies, or contradictions emerge (Borg & Gall, 1989). It is only after data has begun to be collected (usually via participant observation) that technique, strategy, and focus of the research question(s) are generated in the field. Although "foreshadowed questions" (Wilcox, 1982) were used to help focus the study initially, themes and hypotheses began to emerge as the research was conducted, and were developed and refined throughout the project.

Addressing Reliability and Validity Issues

Yin (1994, p. 36), suggested that the most common method for enhancing the reliability of a case study is to operationalize as many steps in procedure as possible, so that an external audit or another investigator might conduct the exact same case study with (hopefully) the same results. Further strategies for dealing with the four most common tests of quality for any research design were proposed by Yin (1994). These include construct validity, internal validity, external validity, and reliability, and are are summarized in Box 1 as they apply to the case study.

Based on Yin's suggestions to reduce threats to reliability, case study protocols were developed and refined to provide stringent documentation of the procedures followed. Additionally, a formal case study database was developed to corroborate and verify all findings. To enhance construct validity, multiple sources of evidence (observations, interviews, documents) were used to support all major conclusions, with 'chains of evidence' clearly recorded (see Appendix G). Key informants were asked to review findings and verify sources attributed to themselves.

Box 1
Tests of Quality for Research Design

Test of Design Quality	Case Study Tactic
• construct validity	—multiple sources of evidence, establish chain of evidence
	—have key informants review draft case study report
• internal validity	—pattern-matching, explanation-building, time-series analysis
	—not applicable to descriptive or exploratory studies
• external validity	—analytical (as opposed to statistical) generalization
	—replication logic (multiple case studies)
• reliability	—use case study protocol, develop case study data base

External validity is commonly based on generalizing findings from a "sample" to a "population". From a naturalistic inquiry perspective, however, generalization in its traditionally scientific definition is not the end-all, be-all of scholarly investigation. In this study, as suggested by Yin (1994), analytic generalization, or the attempt to generalize findings to a broader theory, was undertaken by the researcher. An intuitive, empirical type of generalization of a situation from the perspective of the reader is the goal of this study. It is hoped that people will understand more deeply if information is presented in the form with which they are most familiar. It is this philosophy that underscores the significance of this study. Because of the philosophic foundations of individualization inherent in educational programs for students with special needs, and the unique nature of the subjects being studied, there is only the hope that readers will make naturalistic generalizations to situations and students based on their own knowledge and past experiences—those that will extend their own understandings of the use of technology by students with severe or multiple disabilities. Because the issue of internal validity is irrelevant to descriptive or exploratory studies (Yin, 1994, p. 35), and relates only to those studies that seek to create a causal or correlative case, it is not addressed in this study.

Data Collection

Methods for collecting data included participant observation (both field notes and videotaped observation), interviews, and a thorough search and review of records. A protocol for each type of data was developed and refined throughout the study to provide a systematic method of recording, analyzing, and documenting various pieces of information.

Participant observation. Participant observation was chosen as the primary data collection technique in the study, which began in the summer of 1997, during the district's Extended School Year (ESY) session. To enhance procedural reliability for the case, a case study protocol (see Box 2) for observations was developed and followed throughout the data collection process.

Box 2

Observation Protocol

- gain proper permissions for filming
- establish researcher role and gain cooperation of key ESY staff members
- discuss/confirm taping schedule(s) with appropriate staff
- OK random observations with appropriate staff
- Tape and/or observe the subject
- repeat steps 1-5 with educational staff for Fall 97 semester

After permissions for filming and observations were gained, discussions were initiated with key staff members of the ESY program to establish the researcher's role and agree upon a schedule for observations. It was agreed that observations would occur 2-3 times weekly, on average, during regularly scheduled computer-assisted learning activities and "free-time" use of computers, with random visits of at least two 20 minute periods per week.

Although the taping sessions were originally set up to occur on a consistent schedule, it quickly became apparent that this was procedurally impossible. Difficulties that arose included 1) "scheduling" for use of technology was extremely fluid and constantly changed due to a myriad of factors, i.e., number of staff available, field trips, student behavior, and the total number of students in attendance, 2) an initial delay of 2-3 weeks, while technology was being set up and staff familiarized themselves with the equipment as necessary, and 3) Travis was irregular in attendance throughout the summer.

Throughout the fall semester of the 97-98 school year, Travis was observed across a variety of settings in the educational environment. Classroom observations in this setting were plagued with many of the same scheduling problems as the summer session. Thus, Travis was videotaped and observed somewhat randomly throughout the fall semester, with the limitations of an imprecise and changing schedule again affecting the number of sessions and times of observations. However, flexibility was observed, and observations were determined in collaboration with school staff to best meet the needs of the student and teachers and to limit the amount of intrusion in the students' daily routine. Observations occurred in the special education lab, regular classroom, "specials" (art, music, P.E.), computer lab, cafeteria, field trips, and at special events such as parties, plays, or speeches. Travis, who had been videotaped many times prior to the study, was accustomed to the taping, and for the most part, totally ignored it. Videotapes and/or detailed field notes were used to document each observation. Each tape was transcribed following the taping session (see Appendix C) and added to the case study database (Appendix E). Field notes (non-video) are listed in the Record/Documents log (Appendix B), and entered into the case study database (Appendix E).

Interviews. Interviews provided another strong component of data collection in this study. During the initial stages of the study, five professionals and one family member were chosen from a pool of adults involved or familiar with the subject's technology use. Interview protocol (Box 3) was developed and refined throughout the study.

Box 3

Interview Protocol

- gain proper permissions and release of records
- inform participants, establish researcher role, and gain cooperation
- request/schedule times with potential interviewees
- provide advance list of question areas
- interview and audiotape
- transcribe each session
- review for emerging themes/development of coding
- develop follow-up strategies
- prepare additional questions, new interviews as necessary

Interviews with ESY staff began early in the 1997 summer session. The first teacher interviewed (T4), a fourth grade special education teacher, was also his teacher in the fall semester. The second teacher (OIS), an ancillary staff member with a specialty in orthopedic impairment, had worked with Travis previous to the ESY experience. A paraprofessional (PP) who had two years of professional experience with Travis was also working the ESY session and agreed to be interviewed. During the 1997-98 school year, the school physical therapist (PT) and Travis' parent (MO) was interviewed. Each interview occurred in the school setting or in Travis' home (mother's interview), and varied in length from 45 minutes to two hours. Each, with the exception of Travis' mother, was an employee of the school system described in the study. Non-directive probing was used in initial interviews, and an advance list of questions was provided to the interviewees (see Appendix A).

All interviews were subsequently transcribed, coded into categories relevant to the foreshadowed research questions, and also reviewed for new or emerging themes. A log of each interview was recorded (see Appendix D), and each transcribed interview was added to the case study data base (Appendix E). To avoid redundancy in citing quotations from each interviewee, a code was created to represent each informant. Box 4 provides the codes that will be used to cite observations/statements made by each.

Box 4

Key informants/interviewees in the case study

Code	Position
T3	Special Education teacher, third grade
T4	Special Education teacher, fourth grade
PP	Paraprofessional
OIS	Teacher/Orthopedic Impairment Specialist
PT	Physical Therapist
MO	Mother

Records and documents. An indepth review of documents and information was undertaken to broaden and enrich the contextual perspective for the study. At the beginning of the study, a protocol was developed to systematically search and obtain records pertinent to the investigation (see Box 5).

To begin the search, the researcher asked for complete access to all permanent school records. Teachers were asked for data from working files, examples of completed tasks, behavioral charts, daily notes, progress reports, printouts of performance data, hard copies of the student's work and any other documentation related to educational goals and academic tasks. Parents were requested to look for all records, school work, pictures, or other relevant information.

Box 5

Records/Documents Protocol

- gain proper permissions and release of records
- access permanent folders from central administration offices
- access any other information from central offices
- access material from teachers
- access material from parents
- review all materials for relevant information or artifacts
- search for overlooked sources

Travis' permanent folder was accessed and reviewed fully. Teachers provided artifacts such as work samples and copies of notes home to parents. Evaluations and summaries prepared by individual staff members were collected. Materials used for communication training were donated.

Inservice materials used to train staff and peers was collected. All records were logged and entered into the case study database. A list of all records gathered and reviewed are provided in Appendix B.

Data Analysis

Data was compared in an ongoing fashion to shape the direction of the study as themes or inconsistencies began to emerge. Interactions that occurred in one setting often provided important clues to gathering additional information from other settings. Each component of the data was used to further anchor information, resulting in themes and conclusions verified by a triangulation of sources. Procedures for analyzing and interpreting data are described in Box 6.

Box 6
Procedures for Analysis of Data

- transcribe each videotape and/or interview within a week of receipt
- analyze and review each artifact as received
- maintain a log of all materials
- code and analyze information as soon as possible as it is gathered
- compare and contrast emerging themes
- review emerging themes or negative cases
- develop follow-up strategies

Following this protocol, each videotape was reviewed several times and a transcription of the action made and placed in the case study data base. Each interview was transcribed as soon as possible following the taping session. Initial analysis was undertaken to explore questions, themes, or issues emerging from the data. Data was coded by category regarding variables broadly proposed by foreshadowed questions, i.e., achievement, behavior, communication, motivation, self-esteem, social interactions, etc. Additional questions and a second set of interview questions were generated from the data, in preparation for more focused followup interviews. As videotaping and observation continued, pattern-matching was used to compare new information to prior findings in an ongoing fashion. As themes and patterns began to appear, pattern-matching and explanation-building was used to hypothesize some explanation of events. As Travis' behaviors at various computer tasks began to show wide variance, for example, tentative hypotheses were explored to investigate plausible or rival explanations.

Interpretation of the data. Because this study was designed as a naturalistic, holistic investigation, with a primary goal of providing descriptive information, all data was necessarily filtered through the experiences and opinions of the investigator. Therefore, special care was taken to keep subjectivity at a minimum. Using the principles for establishing construct validity and reliability, as proposed by Yin (1994), the following methods were undertaken. To avoid misinterpretation of the data, methods included a verification of conclusions by a convergence of multiple sources, providing triangulated confirmation of each conclusion. To enhance the reliability of the conclusions, a case study database (Appendix E) was created to provide verifiable sources of evidence for those who may wish to review the case. An audit trail to allow external substantiation of the investigator's work is also provided (see Appendix G). In addition, key informants (Travis' mother and one of the ancillary teachers) were asked to review sections of the report that involved data pertinent to their interactions and perceptions. In addition, an ancillary teacher and an objective, uninvolved community professional, who is an authority on augmentative communication training, were asked to review preliminary findings and key sections of data and related conclusions for purposes of alternative explanations, misinterpretations, and/or alternative hypotheses.

Writing the Case Study

The case study was approached by exploring the data in each of several category domains, i.e., achievement, communication, behavior, self-esteem, social interactions, and expectations of others. In each section, findings were presented in a consistent pattern. Observations were presented, then analysis or discussion and conclusions. Although an attempt was made to focus on each domain area, there are instances where data and discussion overlap. Because of the holistic nature of this subject area, there were variables which simply could not be isolated. Behavior and communication, for example, were found to be so intricately entwined they were practically indistinguishable. Travis' behavior was his way of communicating, and his lack of appropriate communication methods had intensive, pervasive effects on his behavior.

Throughout the study, excerpts taken from videotaped observation notes were offset and treated as quotes. Use of editing and bolding for emphasis were taken as the writer's prerogative. Bolding was also used in the presentation of interview quotes. A description of all products mentioned in the study can be found in Appendix F.

Areas of Investigation

On initiation of the project, broad questions were framed to begin examining how technology might affect Travis' educational experience. "Foreshadowed questions" (Wilcox, 1982) were posed to allow the researcher boundaries within which to begin the search for themes and variables (see

Box 7). Questions were framed around common areas of functioning for students in the educational setting, such as academic achievement, communication, social/interpersonal interactions, and affective issues (motivation, self-esteem). The expectations of significant others were examined through interviews and observations. Expectations and goals (of others) served to anchor areas by which the impact of technology in Travis' life was examined. To provide a starting point for this process, Travis' Individualized Educational Program (Document [Doc] #2) was reviewed, revealing goals in each of the functional domain areas. In the educational setting, the actual pursuit of those goals was investigated to see how technology might be affecting learning, performance, and interactions in Travis' environment. In each domain, observations regarding the impact of technology is described, with discussion and conclusions following.

Box 7

Foreshadowed research questions

1. In the educational setting, what is the impact of microcomputer (or other assistive technology) use in areas such as achievement, behavior, motivation, self-esteem, social interactions, participation/inclusion, etc.?

2. What is the impact on the attitudes, beliefs, or expectations of significant others toward individuals with disabilities in the educational setting? When new tools are used successfully, are the expectations of significant others concerning student abilities affected? Are educational goals affected?

3. How does the use of assistive technology affect the educational environment of individuals with severe or multiple disabilities?

CHAPTER IV

Travis: A Case Study

Travis H. (see Figure 1) is an 11-year old fourth grade student at a mid-sized school district bordering a large Midwestern city. He spends most of his school day in the special education lab, receiving educational services associated with a severe communication/speech disorder, limited mobility and motor skills, and cognitive retardation.

Travis was born in Brownsville, Texas, where environmental poisoning was responsible for a number of nuerotubal birth defects in children born around that time. He was born with multiple neurological anomalies, including a posterior encephalocele (protrusion at the back of his head) which required immediate surgical repair upon birth. During prenatal development, Travis' brain had failed to close off normally, and his corpus collosum (the transfer station between the two sides of the brain) failed to develop normally. There were facial abnormalities, most noticeably his eyes, which were too far apart and on the sides of his head, and an "almost missing" nose. In his earliest years, a number of surgeries were required to rebuild his nose and improve his vision and swallowing. Since then, Travis has had a rizotomy to remove nerve roots that were causing tightness and muscle spasms, an osteotomy to repair a hip socket, eye muscle surgery, and several other minor types of surgeries to help improve his physical functioning.

Despite the many limitations that resulted from this difficult beginning, Travis has many abilities. He can wheel his chair short distances, use a walker for limited tasks, and strongly express his likes or dislikes with gestures and facial expressions. He can see, although he often uses peripheral vision and does not appear to be looking at an object or the person interacting with him. He uses a computer that has been adapted with switches and a special joystick. He uses a set of picture icons, supplemented with a few simple, voice-augmented devices, to respond to questions and express his needs. Travis uses a switch and switch interface to control electrical equipment, such as a tape recorder or blender, in his environment.

Although Travis cannot speak, he is quite expressive. He is strongly opinionated and can make definite choices about participation in events or assigned tasks. Travis uses body language and facial expressions very effectively. He is quick to express affection or agreement via use of a huge, charming smile. With facial expressions, he is equally quick to express distress when people get in his space, talk down to him, or limit his independent nature. He uses a single hand sign, that of "finished", to express a wide variety of negatives. He points, pulls on people, and vocalizes sounds like "ahhhh" and "eeeeee". The tone and level of his sounds go up and down, and clearly express a spectrum of feelings that range from pleasant or pleased, to extremely intense objection or anger.

Travis is a mystery to many of the adults who work with him daily. Described at various times as "mentally retarded", "multi-handicapped", or just a "normal little boy inside of a malfunctioning body", there is much confusion regarding the degree and scope of Travis' cognitive abilities. Evaluation of his cognitive abilities is very difficult, nearly impossible, due to severe limitations in his ability to demonstrate skills. He has a limited range of motion and limited motor skills--he cannot speak, write, cut, paste, paint, or point effectively. Yet, Travis is determined to be very independent, and he tries doggedly to feed himself, toilet himself, use a computer, walk with a walker, and transfer in and out of chairs. He can do each of these things partially, albeit with great amounts of perseverance and energy on his part. Needless to say, his educational performance is affected because of these limitations. Testing and intelligence scores come out very low, and skill levels are very difficult to evaluate.

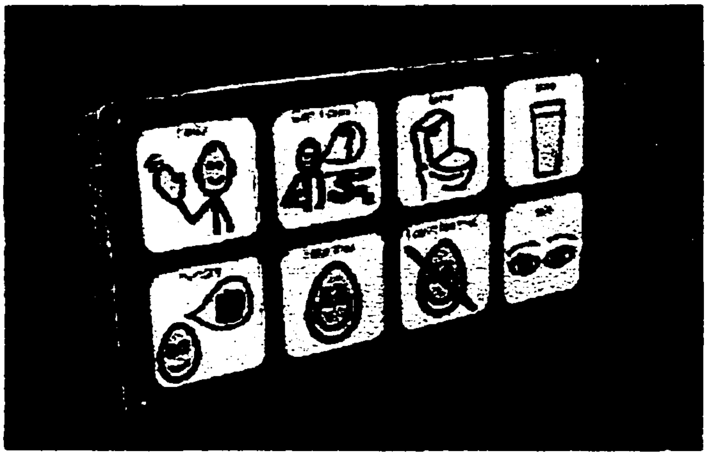
FIGURE 1. Travis at the computer

History of Technology Use

Travis began a special preschool program at the age of three months. His family lived in Tennessee, where he continued to attend special education programs throughout his early childhood. He was first introduced to computers and augmentative communication in the preschool program

(Mother's interview [MO], p. 1). When Travis was four, his family purchased a voice-augmented communication device, the Introtalker (see Figure 2), for him. After programming the new device, his family was astounded when he immediately began using it to ask for more food. When they quickly gave it to him, he went on a request-and-feeding binge that lasted several months, using the Introtalker purposefully and spontaneously to ask for food. "He was constantly asking to eat, and eating every time he asked" (MO, p. 2). His parents, realizing they hadn't been feeding him enough, began to increase his portions and feed him more often. Soon, he had no need to ask, and as the device lost its functionality, he quit using it.

Figure 2. The Introtalker was Travis' first communication device.



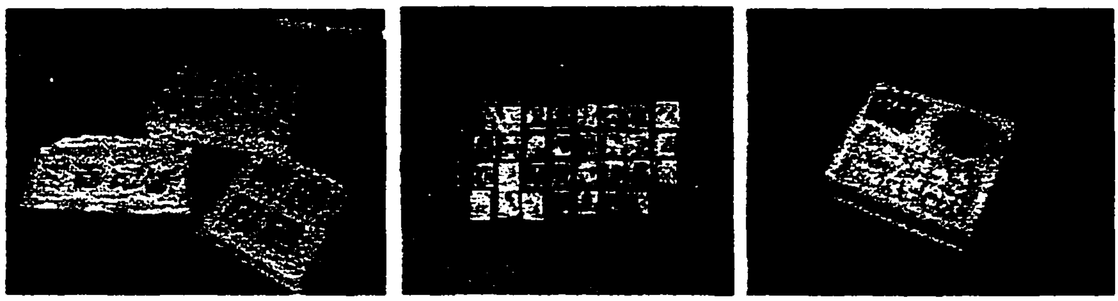
In the fall of Travis' sixth year, he moved with his family across the country from Tennessee to Oklahoma. By this time, he had totally abandoned the Introtalker, and expressed strong displeasure when attempts were made by school staff to solicit its use. At home, Travis used a combination of cues, knocking on things, and inaccurate signs to communicate his needs. When angry, he would yell and display an "arching head, screaming rebellion" to show his displeasure (MO, p. 4). His Introtalker was sent to school with him, but he very quickly made it clear to everyone that he did not intend to use it (Orthopedic Impairment Specialist/ Teacher interview [OIS], p. 1). He generally ignored it, and when requested, he would consistently sign "finished" — his way of politely saying "no".

Throughout the next few years (grades 1-3), the school staff tried out many different types of technology-based tools and strategies with Travis. After trying repeatedly to get him to use the Introtalker, several different augmentative communication devices were purchased and set up for him. He had a Speakeasy, a Macaw, and several different types of the CheapTalk (see Figure 3). Each new device was met with mild curiosity and a few days of play, but he would quickly tire of it, and soon afterward, would begin to refuse to use it (OIS, p. 1; 3rd grade Special Education Teacher interview [T3], p. 9). Teachers and speech pathologists created many new and tempting overlays and tried a variety of strategies to engage his interest and increase the relevance of the devices, but Travis would consistently sign "finished" each time he was encouraged to use the device. If pushed, he would become angry and uncooperative. He would stiffen and arch his back, making loud, strident noises. Eventually, staff members, too, would abandon each successive device (OIS, p. 1; T3, p. 9).

In addition to augmentative communication, a parallel effort was being made to help Travis access the computer. His new school had a large number of MacIntosh computers and software available, and many willing support personnel eager to help him develop computer skills (OIS, p. 2).

Because Travis seemed to enjoy the computer, there was great optimism by the school staff that it might be used as a communication system as well as a general tool for learning.

Figure 3. Augmentative communication devices used by Travis in grades 1-3.



The Cheaptalk (3 different configurations), the Macaw, and the Speakeasy.

Travis had a lot of problems with the computer, however. He could not accurately operate the computer via the mouse or keyboard, although he loved to try. His left hand, which had the greatest range of motion, was stiff and his fingers splayed out, limiting his ability to move the mouse or click the button on the mouse. He could not seem to separate these two fundamentally important actions, constantly pressing on the mouse button and stiffly attempting to push it at the same time.

Travis' educational team spent a long period of time exploring access options for him, searching for the type of adaptation that would enable his accurate and independent use of the computer. A touch-activated screen was installed and tried for a period of time, but he could not accurately isolate a pointing finger (the heel of his hand dragged across the screen) and his limited range of motion restricted about half of the screen from his reach. Intellikeys, an enlarged keyboard, was tried. Customized, picture-based overlays were created for it, but he did not seem to make the connection between the pictures on the screen and the pictures on the big keyboard. Simplified overlays were created to help him type high-interest words and phrases with just one button activation, but he consistently opposed the use of the enlarged keyboard, using the same method of saying "no" via his hand signal. After a while, he became impatient with trials of new devices and equipment, and he began to express distress any time he was requested to try a new adaptation. As with the augmentative communication devices, Travis would become angry and defiant when staff insisted he use anything that did not immediately allow operational success (Physical Therapist interview [PT], p. 4; OIS , p. 2).

Even though there seemed to be no easy way for Travis to access the computer, he was able to operate some types of switch-activated software programs. Single-switch, cause-and-effect software, particularly the kind that required repeated pressing of the switch to successively build large, colorful pictures seemed to be his favorite. This type of software was designed so that the picture would eventually complete itself and perform an animated action, without requiring any accuracy in timing the switch activations. And so, although his switch-pressing was basically random, with enough presses, Travis was able to complete this type of computer-based task with a measure of independence.

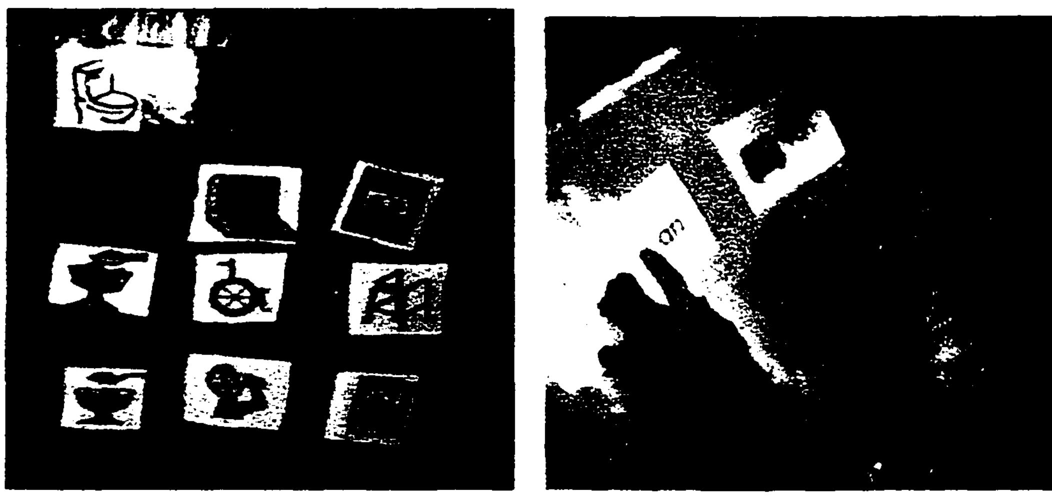
Teachers thought Travis could do more on the computer, though, than the simple cause-and-effect software programs. However, when teachers attempted to direct him to activities with a bit more challenge, they were often met with a noticeable lack of cooperation. When activities required listening to and/or following directions—to "type a T", for example, or to move the cursor to a particular targeted answer—he would begin to object, signing "finished", crying out, and arching his head back in his chair. He did not like teachers telling him which program to use, or that he could not determine when he was "finished". Sometimes, when the misbehaviors began to occur, teachers would reduce the task requirements, and negotiate to get just a few more answers from him. If the teacher would not compromise, though, his behaviors would begin to escalate dramatically. He would begin to buck and rear back in his chair dangerously, make intensely loud and angry sounds. He would pound on his desk and strike out at the staff member until the lesson was aborted, usually with him in "time out" (turned to face the wall with purposeful ignoring by staff), or just "in trouble" with the dreaded note home to Mother. Once the scenario reached a certain magnitude, Travis was stubborn, and would simply not relent. With these behaviors, he was successful in powerfully, though nonverbally, communicating his objections and his strong refusal of what he didn't want to do.

When Travis' computer use was on an independent, exploratory level, his behavior was quite different. For example, Travis reportedly had exhibited very few oppositional behaviors during the third grade school year. In this setting, his teacher reportedly focused on giving him a great amount of independence, with long periods of self-directed time on computer, while just "check[ing] in on what he was doing" (T3, p. 3). During this period of time (third grade), there were instances of staff "catching" him doing things that surprised them. He reportedly learned to move the cursor/mouse to get in or out of programs, move the mouse or joystick to activate the printer, and would work at the computer for long periods of time with good attentional focus (T3, pp. 3-4; OIS, p. 3; paraprofessional interview [PP], p. 7). These rare demonstrations of accuracy, in addition to his level of social interactions, facial expressions, awareness in interpersonal interactions, and his differing responses to various staff and various approaches, convinced some staff members that he was far more capable than he was consistently willing or able to demonstrate (PP, p. 7; T3, p. 9; OIS, p. 4).

Current Technology Setup

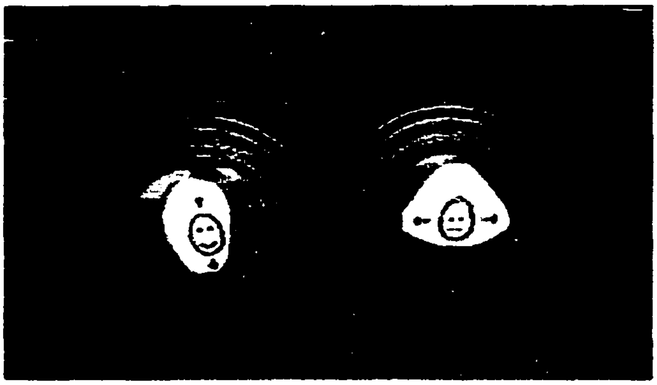
Observations began in June 1997, and continued through January 1998. During this time, Travis was attending an Extended School Year [ESY] program (the summer session between 3rd and 4th grades), and continued into the fall semester of his 4th grade school year. At that time, he used a wide variety of assistive technology, both low-tech and high-tech. A modified picture-exchange communication system consisting of 1-inch square icons (see Figure 4) had been developed and customized to his needs. Printed picture icons were attached with velcro to posters in his classroom. Picture icons were attached under his transparent wheelchair tray or stuck with velcro onto a lapbelt. A large tagboard poster on the wall in his room was used as a "choice board" of icons representing free-time activities (see Figure 4). In fourth grade, a switch-activated chime alert and a pair of One-Step Communicators were added to his system to provide an audible yes/no response (see Figure 5). He used switch-activated loop tapes to tell stories and jokes, and his family provided information about events in his home environment to put on the loop tapes for Travis to share with his classmates and friends. He also used a switch-operated environmental control interface, the PowerLink, for tasks such as turning on music or assisting with food preparation. An upright standing frame with tray was used for positioning at the computer. His computer, a MacIntosh LCIII, was modified with a special switch-adapted joystick (see Figure 1) and an enlarged keyboard with keyguards. Jellybean switches and the Biggy, an enlarged cursor, and a large variety of software programs were provided.

Figure 4. Travis' choice board and other icon-based materials.



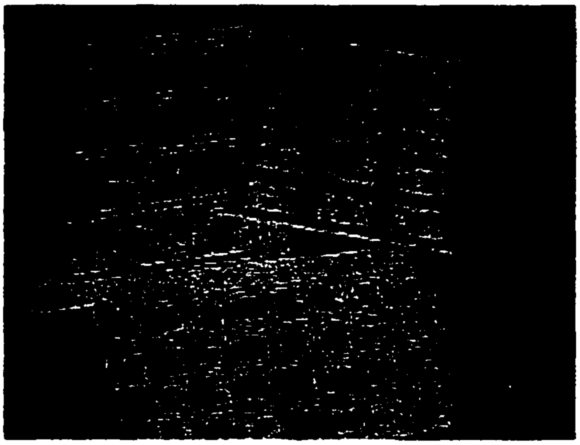
In addition to many types of technological devices, Travis' educational environment was rich with technology-generated materials. A large amount of customized, computer-generated materials were made specifically for him. Boardmaker, an authoring program based on icons taken from the Picture Communication Symbols set (Johnson, 1994), was used to create materials with Travis' own personal set of icons, such as specially formatted activity worksheets and word cards, each using large text and colorful pictures. Visual schedules, mini-choice boards, and visual labels for various objects, using the same icon system, were abundant in the classroom. Visual task analyses were posted for several daily tasks, such as washing hands and delivering mail.

Figure 5. A pair of One-Step Communicators



In general, Travis used the materials, particularly those that promoted autonomy, such as the choice boards and visual task analysis, without objection. Icon-based materials used in "seatwork" activities were generally met with cooperation. Travis worked on the computer several times and was encouraged or required to use his communication system sporadically. The remainder of this chapter will provide additional description of Travis' use of technology in his educational environment.

Figure 6. Situational picture communication boards.



Topics of Investigation

An unusually large amount of technology devices, materials, and support services were available in Travis' school, providing a rich setting for investigation. Broad, foreshadowed questions provided the initial focus for the project. These questions (see Box 7) concerned the impact of technology on achievement, behavior, motivation, self-esteem, social interactions, and the attitudes or expectations of significant others in the educational environment. In many instances, these areas overlapped and merged. However, to help provide a beginning framework for investigation, an attempt was made to focus on each individually, and isolate factors specific to each. The remainder of this chapter approaches each area successively, beginning with Travis' technology use in the area of academic achievement.

The Impact of Technology on Travis' Achievement

How has technology impacted Travis' ability to achieve academically? Student achievement has been defined as progress in a targeted area of academic skills, or what has been learned as a result of instruction (Salvia & Ysseldyke, 1988). When the study began, a number of curricular objectives had already been identified by Travis' educational team, and were listed on his Individual Educational Plan [IEP]. These included a variety of matching and sorting tasks, such as matching words to pictures, sorting one-to-three items by attributes, and demonstrating knowledge of beginning letter sounds (Doc #2, pp. 5-6). He was asked to identify, match, and sequence numbers. Communication goals involved answering "yes/no" questions and using his communication system to make choices and indicate his needs. Travis' behavior was addressed as a "weakness" on the IEP, and objectives were phrased for him which included following verbal directions, following school rules, and respecting the personal space of others. Additionally, a number of more functional goals included participation in daily jobs at school (taking attendance to office, filling water bottle, moving materials from one place to another), and participation in assembly and packing tasks, such as opening and closing containers.

Figure 7. Travis working on a sorting task

Observations of Assigned Academic Tasks

Travis' performance during academic tasks was extremely variable, and difficult to evaluate. In sorting tasks, for example, he would be asked to sort various objects by attribute categories ranging from 'skinny/chubby' to 'red/green'. He did seem to enjoy this type of activity, which involved picking up objects and putting them into one of two bowls. Although he sometimes appeared to be cognitively capable of differentiating between categories, he was inaccurate too often to really tell. Usually, he did not appear to be looking at the bowls, and it was unclear if he really understood the attributes, or if he was just guessing or going to the nearest bowl (VO #2; VO #36). Surprisingly, there was very little documentation concerning real accuracy on any of these tasks. Typically, he put the objects in a bowl, then the staff member removed any incorrect ones, and he was given a second, or even third chance if necessary. Credit was given for completion of the task, regardless of accuracy (VO #11; Fourth grade Special Education teacher interview [T4], p. 7). Sorting tasks were performed with manipulative objects or adapted materials, and there was no use of technology observed.

Matching activities were often performed with materials made with his picture icons. Travis was sometimes required to match an icon to a word or an icon to its beginning consonant sound, using word cards made for him. Again, it was very difficult to determine how often he was just guessing, or how often he really knew the concept. He often appeared to be watching for cues from adults, and they were given with regularity (VO #22; VO #35; VO #36). The following excerpt, where Travis is working with an ancillary staff member, demonstrates Travis' use of cues (bolding is used for emphasis):

> Travis is working w/Ms. W. She holds up two cards with picture icons on them and asks him to point to the word that begins with the sound she is making (match picture/word to initial consonant). He misses the question (chooses left), she tells him he is not listening. He gets the next one (on the left). The last three he has reached for left side. Now they are going to V. "Which one starts with the V sound, Travis? v-v-v" He gets first one, (on left). He helps velcro the card into the book. He gets second one, also on left. She says "I'll give you 2 pennies for next 2". This time correct answer is on right, **he goes to left, but then corrects himself when she makes no response.** Teacher: "yes! you knew that one!" (he just guessed). Next one, he misses, goes to left. After she prompts several times, he goes to right side. She tells him 'excellent", **even though he only chose it after missing first one.** ...... they put two pennies in the jar. Next question: "Find the word that begins with c-c-c" He first touches the card that says mat, she says "are you looking at the picture? He changes to the other card--cat.

"You got it, that's excellent" She holds up the two words reversed and he goes for left again - (wrong)- She says "Are you thinking, are you looking?" and he changes to the one on the right. "Excellent". She presents them again and **he briefly touches left, then goes to right** "correct". Now presented with fat and hat, he touches fat immediately (left). She praises him. Next is "hat"--she holds up fat and hat, he goes immediately for left. "now, wait a minute, that one has f-f-f". He moves to touch the card on the right. **He is looking at other kids in the room this entire time, and just randomly touching one of the cards. She reinforces verbally.** Then says "you know what, I think you need a penny, you have done an excellent job". (edited video notes, 10-13-97)

The scenario depicted above also demonstrates the variability in adult feedback/reinforcement that was apparent throughout the study. This teacher reinforced him both verbally and extrinsically (with pennies which could be exchanged for toys) for random guessing and off-task behaviors. She tells him he "knows" the answer, when he obviously does not, or when he is using her responses and cues to choose the right answer.

In addition to the seatwork activities, Travis was often assigned matching activities on the computer. During the summer session, for example, he often worked on a software program called Switch Intro. Within this program, there was an activity designed to introduce scanning by choosing a picture that matched a target picture. The target picture was on the top half of the screen and three other small pictures, one of which matched the targeted item, were on the bottom half of the screen. When the scan was started, the three pictures at the bottom of the screen were highlighted, one by one, with a colorful border. In this activity, Travis was required to press a switch to choose the picture that matched the targeted picture on top. As described below, in three separate activities, Travis was minimally engaged in this task.

Travis continues to press the switch randomly while looking at another student on his left. He is off-task watching to his left and right. He is not even pushing randomly at this point. The printer goes off and he begins looking at it and listening intently. He seems captivated, almost hypnotized. As he watches, his head is drooping and he appears to actually be falling asleep. He jerks awake when he begins to fall over too far. He would have fallen out of his wheelchair if he had not been strapped in. Now he is looking all over the room, as far as he can turn each way. His chair is locked in. **He seems terribly bored.** He puts his hands up and begins pressing the switch again. **It is obvious to me that he is just pressing minimally to make people think he is working.** (edited video notes, 6-19-97)

Travis is clicking on every box and getting all wrong answers. ......He does not wait for the correct picture....... She gave him some more directions but they were not very clear, --"wait until it gets to the one that matches this one". He attempted to reach for keyboard. She explained that it was her turn to choose. He started to throw his head back. "if you choose to put your head back, I choose to take a penny", she said sternly. **He continued to press at random w/o looking at the screen.** She continued to prompt him to look at screen. When he accidentally got one right, she said 'good job'. (edited video notes, 7-9-97)

The paraprofessional set the timer and walked off. Travis is watching one of his friends, who is at a computer to his left. **On Match/ Scan, he simply clicked on any of the three boxes until he got the correct answer. Then he let the resulting animation go on for a long time. When the paraprofessional says 'click mouse', he does.** She tells him "look, this is the one you want to match, are your eyes where they belong?". He threw his head back, beginning to protest, then returned it quickly. Paraprofessional-"thank you for remembering just in time". She set the timer and left the area again. When I asked him to point to the one that matches, he just ignored me. **Travis watched the other student to his left, and did not appear to be doing anything on the computer.** When left alone at computer, Travis does not really do much of anything. **He seems to enjoy just looking around and watching everyone else.** The paraprofessional came back over after awhile, and got him to do one answer correctly, then was gone again. (edited video notes, 7-22-97)

Throughout the summer, whenever Travis was assigned this type of computer-based activity, the same types of behavior occurred. As illustrated by the preceding excerpts, he did not appear to be engaged in the activity at all, he just pressed the switch rotely as if he was only concerned with keeping himself out of trouble. In these activities, there was no reinforcement for or monitoring of accurate performance. All Travis was required to do was to "keep clicking" at a rate that satisfied the paraprofessional in charge. As with the non-computer tasks, successful achievement on assigned computer tasks was simply measured in terms of completion or tolerance of the activity.

Another task often assigned to Travis in the summer session was to type a list of spelling words. To help attempt this task, Travis' computer was adapted with an Intellikeys keyboard that had large letters arranged in an ABC configuration. There were keyguards to prevent accidental activations caused by his hands dragging across the keyboard. He used Write Outloud, a text-to-speech software that was set up to speak the letters and words that he typed. When summer school first began, Travis was required to attempt this task two or three times weekly, using short words that had been copied onto index cards and placed near the computer screen as models. Travis showed strong opposition to the task, repeatedly signing "finished", crying out, making sounds of distress, and showing angry and disturbed facial expressions, as described below:

> He is signing "finished" repeatedly. ..starting to get mad and beginning to pound on the keyboard. He is frowning angrily and making loud and distressed sounds....He flails at her. The paraprofessional turns and says "Travis, don't you hit me, I don't like that!" ....He is pounding, yelling, his head is arching back. He is really getting mad now. She is holding his hands....he is really escalating. She turns and walks off for a minute, talks

with teacher/supervisor. .. She returns in a few minutes, --"Travis, you have to do this" (now in a calm pleasant voice). He rears way back in his stander......yells out, hits at her. "You are going to finish at least one word" ..... BUT HE DOESN'T, and eventually gets sent to timeout. (edited video notes, 6-16-97).

When staff members attempted to force Travis to complete an academic task that he did not like, he would become combative and usually ended up in timeout (OIS, p. 3; VO #6). Throughout the summer, when Travis was asked to perform the typing task, he displayed a consistently intense range of oppositional behavior (VO #6; VO #8). As shown in Table 3, he fought the assignment each time it was requested. Toward the end of summer school, the staff quit assigning him this task.

There were work sessions, however, where Travis would be very engaged in the activity at hand. A session with his Speech Pathologist, for example, showed him trying very hard to complete an assigned task, cooperating fully, and exhibiting no oppositional behaviors at all.

Travis is in Speech lab working on computer w/Mrs. S. She instructed him, "I want you to find five pictures". He is using a program with large pictures of the Boardmaker icons. MS: "Travis, push the mouse over to my finger. [He points at another student in the room.] Do you want [that student] to come sit next to you?". She motions to the student, and he moves over to sit with them. Mrs. S says "Trav, move the mouse over ..." Travis is looking at the other student, but he reached up to the mouse after a few seconds. She repeats the directions and he begins trying to move the mouse. Using her fingers as a target, holding them in an inverted V on the mouse pad, she tells him to move the mouse to her fingers. The mouse cord is between her fingers......He signs 'finished', and she responds "you've done 2, you need 3 more". She points to the cursor and tells him again. He pushes the mouse off the pad, turns it over, then turns it back. She resets the arrow and asks him if he sees the arrow, and to "wait please. "You're not pushing the mouse, you're just clicking the button. Take your hand off, please". He follows her instructions cooperatively, as she resets the cursor.

..............This program "See, Hear, and Say", highlights the blocks as he moves across. This seems to capture his attention. There are AAC icons on the tray of his stander. Travis continues to work until he finishes his assignment-- moving to five different buttons and clicking the mouse to activate the auditory label on each. He is cooperating fully, and clearly attempting to complete his assigned task. (edited video notes, 12-15-97)

In the session described above, Travis was clearly cooperating with directions given by an adult. He worked diligently to complete the assigned task. His behaviors indicated that he was trying to give accurate responses and operate the computer at a more efficient level. Important to note is that the targeted academic skill involved in these sessions, i.e., listening to an auditory label presented with an icon, was accomplished with no oppositional behavioral. A combination of goals were present in this well-defined lesson. The Speech Pathologist had wisely paired a language-based goal with one of more relevance to Travis--that of his ability to independently operate a computer.

Discussion and Conclusions

Although there was a large amount of technology used to help Travis pursue academic skills, actual gains in his achievement were inconsistent. While technology-based materials (i.e., Boardmaker-generated icons) were used to work on matching skills, there were still many difficulties involved in evaluating any actual gain in this performance area. Throughout the investigation, there was repeated indication that various staff members believed that successful performance meant completion, rather than accurate performance in assigned tasks. One teacher in particular uses a large number of cues and prompts to "help" Travis make the correct choice (VO #22; VO #35). Throughout the summer sessions, where Travis was usually "assisted" by a paraprofessional, there was no monitoring of accurate responses, and very little distinction made between "pressing" and "pressing at the right time to make the correct match".

In the computer-based lessons, there were many problems in the structure of the task itself. In the area of development of computer/ keyboarding skills, for example, Travis was completely resistant to the typing activities, and each session broke down into a huge behavioral struggle with Travis refusing to do the task. In prevailing pedagogical theory, a pre-literate child would not be expected to write (or type) spelling words. Thus, the appropriateness of this task should probably be questioned. Because Travis is not literate, one might suspect that this task held very little relevance, and therefore provided very little intrinsic motivation for him.

Learning and performance, whether using technology-based tools or not, seemed to be affected by a number of variables in the environment that were present regardless of the type of task. Particularly during the summer sessions, there was a profound lack of planning and implementation of instructional principles. Travis was repeatedly assigned software tasks that were boring and repetitive, and which represented little challenge or reward for him. He spent large amounts of time off-task, looking around the room while clicking the switch randomly. As he so nicely demonstrated, he did not need to attend to the screen or engage cognitively in the task--he could quite literally do this type of task with his eyes closed (VO #5). Expectation levels among the staff seem widely differing, with some only requiring that he "click the mouse", and others requiring a more rigorous level of accomplishment. There is a general lack of defined task requirements and criteria for successful completion of the activity. He is told to "work well", but is never told exactly what that meant. He is told to "click the mouse", but never told why. There are enormous problems with consistency of feedback and verbal reinforcement. He is often inadvertently reinforced for inappropriate behaviors and regularly reinforced for performance behavior where switch activations are random and don't really require any active engagement or thought on his part. Thus, it is unlikely that any learning or skill growth occurred as a result of this type of activity.

Conversely, as evidenced in the illustrated lesson with his Speech Pathologist (VO #36), Travis' performance and attention to task improved when pedagogical and motivational strategies were used. First, the activity was structured with simple directions, and clear criteria for completion of the task ("find five words"). Perhaps most importantly, he received direct instruction by an adult who did not leave his area, and his performance was closely monitored throughout the assigned task. Help, such as resetting the arrow when it went offscreen, was immediately available. Feedback was accurate and descriptive ("you're not pushing the mouse, you're just clicking the button"). Travis' attempts at communication were acknowledged each time he signed "finished" or made other gestures. To enhance intrinsic motivation the therapist used relevance, goal-setting, challenge, perceived control, and clear expectations, as recommended by Malone & Lepper (1987). Pairing the task with a skill that was highly valued by Travis (moving the mouse independently) increased the *relevance* of the lesson to him. The task was *challenging,* not too difficult or too easy. She used small, immediate *goals* and challenges by encouraging him to "move the mouse to my fingers". Travis' *perception of control* was increased by this therapists' interaction with him and the mouse. Rather than moving the mouse for him, removing the mouse from him, or physically controlling him in any way, she consistently instructed him to "let go of the mouse, please", leaving the actual control in his hands. When she allowed another student to sit by Travis during the lesson, as he requested, she was purposefully increasing Travis' *perception of control* over his environment.

Other computer-based sessions showed Travis cooperating and performing assigned tasks on computer (VO #7; VO #25; VO #31; VO #34). In these sessions, strategies similar to those used by the Speech Pathologist are seen. These sessions will be described more fully in behavior and motivation sections of this document.

Although technology was used to pursue the academic goals defined by Travis' educational team, there was limited impact on increasing Travis' skills. On technology-assisted activities as well as non-technology based activities, Travis' performances were difficult to assess for accuracy, and often seemed to operate on a criteria of tolerance or completion of the activity, rather than accuracy in performance. The following key points were evident in observations of Travis' performance of academic tasks:

1) Technology was used in Travis' educational environment repeatedly to provide materials and tools for learning. The school system provided a large amount of software, a variety of adaptive devices, and use of technology-generated materials for his instructional use.

2) Despite the large amount of technology supports, there was little evidence of successful learning on targeted academic skills. Although computers were used for assigned learning tasks, including basic matching and beginning literacy, Travis was often either uncooperative or unengaged with the assigned task.

3) Computer-based learning sessions often reflected little use of applied theories of teaching and learning. Travis' assignments were often either too easy (as with the repetitive, boring cause/effect programs) or too difficult (as with the typing tasks). Activities that reflected more attention to relevancy of materials, clearer goals, monitoring and feedback, and use of motivational techniques, resulted in an increase in on-task behavior and cooperation and a reduction in oppositional behaviors.

4) Learning and performance outcomes appeared to be directly affected by the application (or lack of application) of teaching strategies and learning theories that surrounded the use of technology. The technology itself, when used in the absence of sound teaching strategies, appeared to have no impact on learning. When technology was used with a combination of proven strategies, Travis' cooperation and time on-task increased.

The Impact of Technology on Communication Skills

As this study began, Travis was using a modified picture-icon exchange system (see Figure 4), and he continued to use his system throughout the observation period. He used this system consistently for communicating free-time activities and for expressing his preferences, when given choices concerning his own daily schedule (see Table 1). In addition to the picture-icon boards, a few other simple, low-tech devices, such as a signal chime button and various single-message loop tapes, were used on occasion. A velcro belt and apron were created for Travis, to put more icons within his reach. Prepared loop-tape "speeches", with information provided by his mother about events in his life, were used to share personal information with others in both the special education and regular classroom. Toward the end of the study, Travis began using two loop-tape switches for "yes" and "no". These simple devices provide an audible response, and he used them quite accurately to answer simple questions (VO #29).

Observations of Travis' Communication

Travis rarely initiated any communication with the materials in his communication system (icons, looptapes, simple voice-augmented devices). He more often initiated interactions with other students by pointing, pulling at their hands or clothes, or staring at them. When interacting with adults, he tended to rely on body language, gestures, sounds, a smile for "yes", and the sign "finished" for negatives, unless he was prompted to use icons or devices. Although he would occasionally pull an icon off of his choice board without being directed to do so, there was rarely any other spontaneous use of the tools provided for him. He was almost entirely prompt-dependant, answering questions by pointing to "yes" or "no" or making choices from his choice board when cued to do so.

Travis was successful in meeting each of the communication goals listed on his IEP (Doc #2). He was able to use his picture icon system purposefully and appropriately in most cases, even though he relied heavily on prompts. However, there were many times when communication opportunities were limited by the availability of the equipment or icons. Most of the time, he simply could not reach the devices or icons, and Travis' very limited range of motion prohibited his ability to get the devices himself. For example, although a small augmentative device had been programmed with computer-related phrases, it usually was not within his reach during computer activities--only 10.5% of the total time he was videotaped (see Figure 8). Physical proximity to picture-icons from his wheelchair or stander

Table 1

Staff descriptions of Travis' use of technology-based communication

T3 He used that system the very first day..... he took to it right away. He understood those icons and he would use them especially computer, but we filled his icon board with putting in jello and yes and no and when we gave him the opportunity of either sitting in his wheelchair or using his stander, all using icons, he could choose from the whole board if you gave him two choices. He was very consistent.....I think it was very effective for Travis...

T4 I think he likes the fact that he's physically doing something on his own, and something's happening because of it. Especially like in the mornings with the "I'm here" [single message loop tape] switch, and he knows what it means, and he knows why he's pushing it.... and he knows when it's his turn to push it, and he has his arm out and he's ready to push.....he uses the yes and no ones pretty well for answering questions.

OIS He will use the icons, but only if you prompt him. He uses the little voice boxes, but usually only when you insist. But if you hold up two icons, or point to the device and say ..."tell me what you want, or tell me with your device", he will do it. He does use the choice board, if you say "go to the choice board and tell me what you want to do".

PP The icons are extremely effective because we have icons not only for his schedule, but for things that he likes to do such as music, whether he wanted to stand in his stander or roll in his walker, jello, we had a jello icon, a pudding icon, an applesauce icon and it gave him more autonomy than he has ever had in his life, more ability to be a normal nine year old boy.......Before the icons we had to basically guess what he wanted to do. We would say "do you want to do this?" and he would say "uh," which we would interpret as yes or no, depending on his facial gestures and after we would say "go show me what you want to do, go show me on your communication board", and he would roll over or crawl over depending on whether he was in his chair or on the floor and point with his hand physically on what he wanted to do.

Key: T3 = Third grade teacher. T4 = Fourth grade Sp.Ed teacher. OIS = Orthopedic impairment specialist. PP = paraprofessional

was somewhat more consistent (25.5% of the total taping time), as the icons were permanently placed under the trays of his stander and wheelchair. At best, then, Travis was unable to use alternative methods for communication a whopping 74.5% of the total time that he was being videotaped for this study. Often, the devices or icons were pointed out to him or placed within his reach when a staff member intended to ask him a question or give him a choice, such as "what do you want to do, Travis?", or "what kind of snack do you want today?". The communication tools were rarely within his reach unless he was being prompted with a question.

Sometimes, the devices were placed out of his reach purposefully (VO #8). One particular scenario, where he was working with a teacher in the summer session, was illustrative of problems with adult attitudes about the devices. On this day, the teacher reviewed the four phrases on his augmentative device (which were designed to give him appropriate ways to ask to quit, get help, change programs, or take a break), and explained that they were options available to him after he completed his assigned task. "None of these are applicable until you type your name", she said, totally eliminating the opportunity to appropriately express frustration with the task or ask for help (VO #8).

Discussion and Conclusions

The use of technology has made a significant impact in Travis' daily world regarding communication, and there is strong potential for even greater effect. He is clearly using the system that has been developed for him, albeit in most cases the use is prompt-dependant. This study illustrates the enormous number of obstacles involved in providing communication training and opportunities for a student such as Travis, and these obstacles stem from a wide variety of causes.

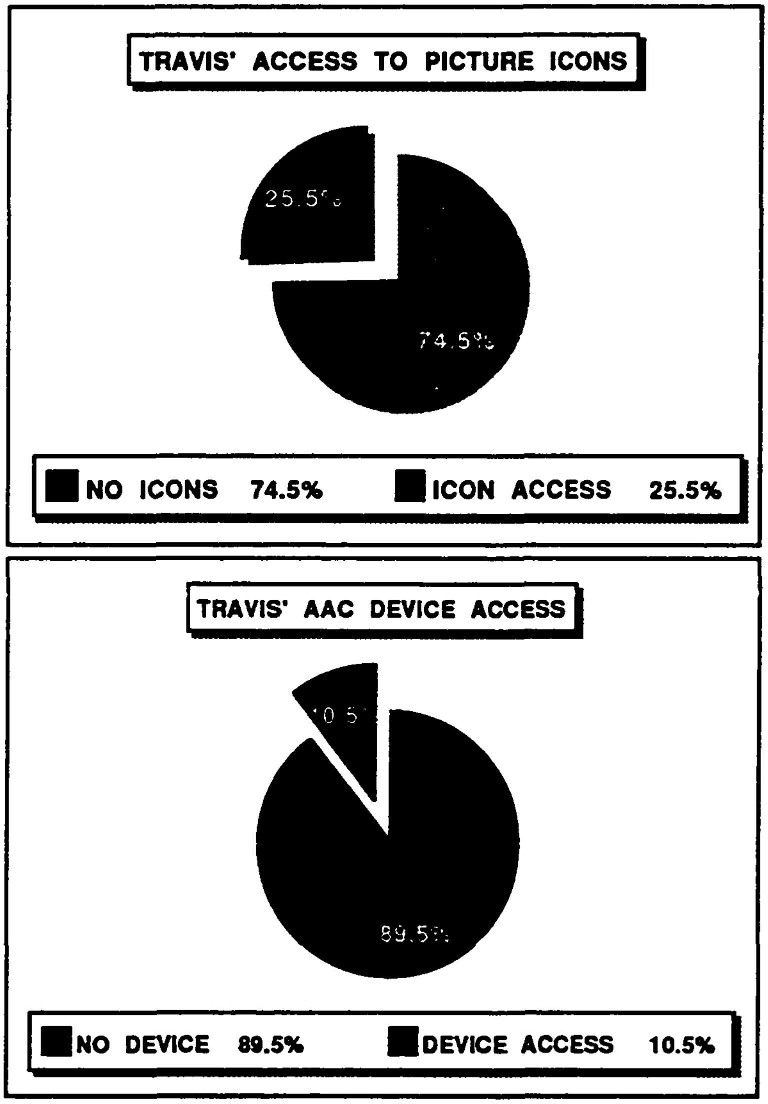
One of the most difficult obstacles to using technology for communication lies within the scope of limitations imposed by Travis' disabilities. In his case, problems with fine motor control limit his ability to point in isolation, and the fact that he most often did not look at the particular icon to which he was pointing, made it really hard for others to figure out which icon he was attempting to access, or if he was "really" trying to say something. It is difficult to determine if he really means to slap at an icon on his tray, or if he is just pounding. So there is a constant use of guesswork on the part of communicative partners to determine what, if anything, he is attempting to communicate.

Use of voice augmented devices would probably help to clarify these problems, reducing the "guesswork" needed by his communicative partner. On the occasions when he is asked a series of yes/no questions, and uses the voice-augmented switches to answer, there is little doubt what he "said", regardless of his intent. This points to the potential benefit of raising the expectations of others in regard to their beliefs about his abilities to answer appropriately and meaningfully.

In addition to the confusion generated by Travis' inaccurate pointing and eye gaze, the proximity of the communicative partner was also a limiting factor. This was illustrated by a speech he gave to classmates (VO #23). Following the speech, when a student asked him a yes/no question, Travis slapped at an icon on his tray, but the class was not able to see the icon. A staff member had to translate by walking over to him, looking at the icon, and stating "he said 'yes'!". It was because of this incident that the augmented switches were provided for yes/no response.

Another obstacle is apparent in the inconsistent accessibility of devices or icon boards. The adults around Travis did not keep the devices or icons available to him, they were out of his reach an alarming percentage of the time. Out of the total time he was taped in this study, icons were out of his reach approximately 75% of the time, and augmented devices approximately 90% (see Figure 8). Sometimes Travis was without his icons because he was not in the wheelchair (they were on his tray and belt), was away from his "choice board", or was unable to free his hands to use them (as when using his walker). The voice-augmented devices carried their own set of problems. Being even more bulky and demanding of upkeep and attention by staff, they were within his reach less often than the low-tech materials.

Figure 8. Percentage of taping time that Travis had access to icons and augmentative communication devices



Note: See Appendix H for supporting data.

Care-giver understanding of the purpose of the devices can dramatically affect communication opportunities for a child who cannot speak. Like the teacher who reviewed the phrases on the augmentative device, then placed the device out of his reach, explaining that the request-based phrases were not options until he finished his work, many of the staff seemed to believe that there was no need to allow him to (use the device to) say "I want to take a break", for example, when he was not going to be allowed to take a break.

It seemed that the devices were most often placed within his reach when the staff wanted to ask him a question or wanted him to make a choice. Although this does provide Travis some choice and control over his actions, it still basically restricts his choices to those that are presented by the staff. He can only respond to the choices presented--chocolate or vanilla, yes or no. He can never say "my favorite is butterscotch pudding, I don't like those two flavors", or "can I eat this later?", or "can you get me something besides pudding?". Because the low-tech switches and icon boards are very limited in the number of phrases provided, spontaneous communication was very limited, and autonomous communication almost totally restricted.

Unfortunately, attempts to use more sophisticated voice-augmented devices--those that could provide a greater number of phrases or greater flexibility in accessing phrases--over the past years had met with no success. Travis had a long history of consistently rejecting the more sophisticated voice-augmented devices, showing a preference for low-technology or no-technology materials. Although there was much speculation by staff and family members, and a continual exploration of different access methods, adaptives, and strategies, no one really knew why he was so determined to reject the devices. It was virtually impossible to tell if visual problems, motor problems, attention span, willingness to persevere in learning the devices, or some shifting combination of these problems was behind his consistent rejection of the devices.

In conclusion, the impact of technology on Travis' communication skills was variable, and reminiscent of the old analogy about the half full/half empty glass of water. While it did appear that communication was positively affected on the occasions that Travis had access to the materials and systems provided, that communication system was still limited to the small number of phrases provided by the low-tech icons and simple one-message loop-tapes. Physical access to materials and devices was inconsistent and often missing. One could surmise that the limited communication opportunities increased the frustration that Travis must have felt. Technology, which could have relieved some of that frustration, was underused or inappropriately used, and therefore had little impact on learning communication skills or on a the learning of higher-level operational skills that could result in an increased repertoire of communication phrases. In conclusion, the following key points are summarized for the reader below.

1) Travis preferred simple low-tech or no-tech devices and materials to more sophisticated augmentative communication systems. As a result, the actual amount of communication phrases available to Travis was very small.

2) Although there was an obvious effort to provide materials and devices, Travis had limited physical access to those tools, resulting in restricted opportunities for spontaneous or appropriate communication.

3) When materials were accessible, communication skills were positively impacted by the use of a computer-generated icon system and

various supplemental low-tech devices. Travis was able to use those materials to communicate need and preferences, thus providing more control and choice in his daily activities.

Behavior and Communication

Travis' behaviors were the major vehicle for mediating his educational experiences, and he used them to communicate his feelings and control his environment. His interactions were rich and varied, and carried a wealth of information about the inner workings of a fascinating young man whose experiences in education and life are so unique.

Travis' behaviors. Most of the time Travis appeared to be happy. In general, he was pleasant and caused no problems. However, observation of Travis in the school setting revealed frequent instances of inappropriate behaviors. When Travis was required to meet a simple set of directives that didn't appeal to him, or to stay with a specific activity when he didn't want to (a situation that occurred with regularity), he would object by signing "finished", by presenting an angry expression that clearly showed his displeasure (see Figure 9), and groaning or yelling with a loud and disruptive guttural verbalization (VO #4; VO #6; VO #35). If he did not succeed in making his point, he would throw his head back in his chair or stander, stiffen his body, pound on the desk, and yell or make disruptive noises (see Table 2). As a consequence, he lost reinforcers or was scolded, and usually was given several more opportunities to comply with adult directives. Eventually, if Travis continued to refuse to comply, "time-out" (being turned to the wall in his wheelchair or stander and ignored for a short period of time) was imposed, and, as required by the IEP, it was reported on the daily note home to mother with a brief note regarding the behavior (see Table 3).

Figure 9. Oppositional behaviors at the computer.

Table 2

Descriptions by key informants of Travis' oppositional behaviors

PT Usually he will **rear or throw his head back and squeal, and make a face, and if that doesn't work, he'll slap ya.** And it's not a hard slap, but it's definitely enough for you to know that you've been chastised... and it does get the point across.

PP When he doesn't want to do something, he throws a tantrum. ....when he **throws his head back and throws a fit** and doesn't want to do something.

T4 He'll get louder and he'll be more uh.....enforcive, I guess....insistent, yes, and that goes along with his physical things that he's doing too...**When he gets upset he likes to reach an arm out and slap or hit, he also likes to throw his head backwards,** I guess he's trying to get away from the evil person that he's working with (laughs).

MO Generally, he falls back on that **arching head, screaming rebellion**....He's very vocal and he **lets us know his displeasure verbally by yelling.**

Key: PT = Physical Therapist. T4 = Fourth grade teacher. PP= Paraprofessional. MO=Mother.

Travis' most strongly oppositional behaviors were observed at the computer. The daily requirement that he complete an assigned task at the computer often became a battleground for behavioral struggles of enormous proportion (see Table 3). He would very purposefully refuse to follow directions, becoming agitated and unhappy (VO #35). He did not like teachers working with him, prompting him to "press the C", or "click now" and would begin to sign "finished", and turn his attention toward any other sound or action in the room (VO #5; VO #6; VO #8; VO #11; VO #13; VO #14). He would not "wait" to press the switch at the appropriate time. The more effort that a teacher put into getting him to comply, the stronger his objection became. At times, Travis' behaviors would escalate to an intense level, with him rearing back dangerously in his chair or stander and exhibiting very angry gestures, facial expressions, and vocalizations. If staff further insisted on compliance, and made the mistake of getting too close, he would flail at the offending adult, often landing an effective strike on their face or body (Table 2; VO #1; VO #4; VO #6; PP, p. 8; PT, p. 3; T4, p. 2). When this occurred, scolding, loss of reinforcers, or being placed in "time-out" did not seem to bother him. He simply refused to cooperate until left alone (OIS, p. 3; VO #30).

Table 3

Excerpts from daily correspondence sent home to parents--1997 summer session

6-9	work today was a bit of a trial; however, did not get out of all of his tasks. He did spend time in time-out.
6-16	Travis began a super job on his walker today. ....When it came to work on the computer; however we certainly resisted. He was hitting at me all during the assignment - had actually earned free time but lost it by hitting me - so more work.
6-17	Travis has had an unbelievably awful day today. He has been hitting all day. He lost his privilege to go on the library field trip because he was hitting. ... I have no idea what is going on, if you have any ideas or suggestions, please let us know. This is making Travis and everyone involved extremely miserable.

Table 3. (continued)

6-18	We are still experiencing a lot of resistance when it comes to work on the computer. He did earn recess time and enjoyed making his snack. Resisted again after all the gym time when we were working on computer again (doesn't seem to matter what program, either).
6-28	Travis refused to do anything involving computer or work of any kind. ... There was hitting, major whining, head butting, and finally he put his head on tray and refused to do anything.
6-30	Hitting and head butting; however he earned himself more pennies by independent decisions on the computer ...
7-7	It seems that Travis has accepted me – we have had pretty consistent behavior last week and now this week thus far. He is working and I am able to back off and allow him more independence as long as he continues to cooperate.
7-9	...refused to work once on the computer (hitting, throwing his head back etc). I simplified the task and he ...eventually earned 10 pennies.
7-15	He was hitting at me all morning long;....even after raising his hand for help - as I approach he would begin hitting. ... he had so many opportunities to work himself out and chose not to.

Many different approaches were tried by the staff to alleviate the behavior difficulties. Different computer adaptations and software programs had been tried throughout the years. Teachers varied conditions in the classroom, changing work schedules to provide a quieter, less distracting environment with fewer students in the area. Environmental factors, such as light, placement of the computer station, and the use of screens to further limit distractions in the room were manipulated and tried in different configurations (VO #1, OIS, p. 2). Different strategies were constantly being tried to reinforce appropriate behavior and/or decrease oppositional behaviors. Teachers tried delivering pennies and other tokens as reinforcers (VO #3; VO #6; VO #7; VO #8; VO #10; VO #11; VO #13; VO #14; VO #22; VO #24; VO #30; VO #32; VO #35), but they appeared to have only limited effect. Although he sometimes would cooperate briefly for tokens, once his opposition reached a certain point, the pennies had no effect at all. Other times he was scolded and ignored (or both). However, when Travis made up his mind he was not going to do something, nothing seemed to have any effect on him, and once the behaviors escalated, he simply would not relent.

There were occasions where Travis appeared to be engaged in successful, productive work sessions at the computer, and many additional instances of perseverant and cooperative behavior. For example, a computer activity taped early in the ESY session showed Travis cooperating fully, following directions, successfully performing tasks, and using appropriate methods for communicating. In this session, a skilled teacher provides Travis with measures designed to facilitate intrinsic motivation, i.e., control, curiosity, challenge, relevance, and immediate goals, as described below:

> OIS: "which one would you like'? want to try that one? ... good choice". She is reading the choices from the menu. **Travis chooses,** clicks, and Hit'NTime comes up. She asks "what will happen here Travis?, let's make something happen", she shows him how to reach up and move to the helicopter. **Travis listens, watches, then attempts to do the same.** She is encouraging him, "that's terrific, now what do we need to do? is it gonna come down?" She is continuously talking to him, defining what is happening, giving him directions. [she is pointing and counting and talking about colors, **Travis is very oriented to screen throughout this lesson**]. OIS: "do you like that red balloon? we missed it again" "Look at that clown! Where did the clown go?" [note: instead of 'eyes on screen, look at the screen.'] She directs him to use talker, suggested he use 'I want different program', he picks 'I need some help please'. **[cooperates with her directives]** She responds, "do you need help picking another program, I'd be glad to help you." Again, she reads choices for him, encouraging him to choose one. He chooses Intellipics. OIS: "I see a big frog, let's go down to the frog, find the frog, and click. ribbit, ribbit, what can we make the frog do, the frog can grow. oh he got big,..... No we're not finished, we're gonna work (2 signs). Would you like to get a picture of the frog, yes?, let's go and print that one", she does the commands for him. He is looking at the printer, waiting, looks very **eager and happy**. OIS: "What are we printing, are we printing a frog, when you go over (to your desk)... you can color it green". He takes the printout when she hands it to him, and immediately holds it up to me, smiling widely. **[note: (analysis of tape)**

> **Travis on-task throughout the major part of this session, cooperative, following directions.** AAC device w/in his reach all time. Finished sign is recognized. **Travis is on-task a good 80-90% of this session.** No pennies used. Tray is used w/stander. He is **watching the screen or the OIS throughout most of this session.** (edited video notes, 6-24-97)

In addition to her skillful use of strategies to increase motivation, this teacher provided opportunities for Travis to communicate appropriately. Throughout the session, the teacher verbally acknowledged each instance of his communication efforts. Each time he signed "finished", she responded to him with "No, we're gonna finish our game, then you'll be finished" or "one more and then you may be finished". She directed him to use the augmentative communication device sitting on his desk, by pointing to it and encouraging him to "tell me if you would like to play another program" or "tell me if you need help".

Other sessions showed Travis cooperating fully with task requirements. In a December session with his fourth grade teacher, Travis was playing a favorite game, Millie's Math House, while using an adapted joystick. The joystick was one of many input adaptations that Travis used on ocassion. With this device, he was experiencing good success with moving the cursor around the screen. Although slow, this method of computer access gave him more effective control of the cursor, a matter of great importance to Travis. On this day, he was fully engaged and attempting to follow directions given by the teacher as described below:

> Travis w/ Ms. H, he is using the joystick. They are unaware of my presence. She is instructing him to use the joystick, it is slanted and has clothespin. They are working on Millie's Math House (Big, Little, & Middle). **He lets go when she tells him to,** and clicks. She tells him "we've got to go down", he grabs joystick and pulls toward himself, "keep going down", she helps him with the fine details. He clicks. **He is intent upon this task, leaning**

forward eagerly. His eyes never stray, he hasn't looked up at all. Ms. H.: "uhoh, we've got to go up, so his feet won't hurt" [shoes are too little]. She is gently tapping underneath his hand. He lets go, but does get it again. "We've got to move the cursor down". "Can you go down.? [he does]......... Ok, we want to quit, so we have to go all the way over to ... " she helps him move his hand. "and then you're [there]". NOTE: Here, Travis is having no problem with her "helping" him move the joystick. He accepts her help and directions w/no objections. NOTE: She is using a hierarchy of prompts. Tells him something, then taps on joystick, then taps on his hand. She resets the cursor so he won't randomly activate something,--he will have to move the cursor. Instead of hand-over-hand, she leaves his hand on joystick , but she helps him move the joystick by first tapping , then pushing on it from the stem. (edited video notes, 12-8-97).

Videotaped sessions of computer work with his speech pathologist, as described earlier in the Achievement section of this document, had also shown Travis cooperating in a similar fashion. He was attempting to complete tasks successfully, working hard, and attending to the task for long periods of time (VO #25; VO #31; VO #36).

A review of all of the sessions showed several successful teaching techniques common to the ocassions where Travis is cooperative and engaged. In each instance, a teacher was sitting with Travis, giving instructions, feedback, and reinforcement for accurate performance. Each of those teachers challenged Travis to perform a task. In each session, he was working on skills that were relevant and valuable to him, i.e., moving the mouse, moving the joystick. Directions were appropriate, the teachers didn't talk too much to him. They were not "cheerleading" or empathizing. Their focus was on internal motivation, rather than controlling or forcing him to do the task. In each session, he was expected and required to use his icons or a device to answer questions. The content of his answers was respected. When he signed "finished", they simply recognized his communication with "no, we're not finished", or "one more and we'll be finished". Directions were clear and simple, and feedback was accurate. Small, challenging goals, such as "can you make the helicopter go up?", were interspersed throughout the lessons. Additionally, the assignments themselves were more appropriate or motivating for Travis. They were not too hard, as with the spelling tasks, or too easy, as with the repetitive one-switch softwares shown over the summer sessions.

Discussion and Conclusions

In school systems, behaviors are often divided into two categories—those that are appropriate and those that are not. Student behaviors considered appropriate in school systems might include following teacher's directives, working quietly, finishing assigned tasks, maintaining a reasonable voice level, compliance with school and classroom rules, behaving in a safe manner, and showing respect for others. Inappropriate behaviors often include a refusal to cooperate with simple directives from teacher or staff, refusing to work on assigned tasks, loud and disruptive verbalizations, "tantruming", attempting to harm another person, and placing oneself or others in danger.

Travis displayed many of the "inappropriate" behaviors listed above. Unfortunately, his misbehaviors were usually seen in one-dimensional terms, i.e., "bad", or " inappropriate", as is common in school systems. There was little to no examination by staff regarding the communicative intent underlying his behaviors. Yet Travis did use his behaviors to communicate his feelings and control his environment. The behaviors were, for all practical purposes, the only effective method available (from his perspective) to get his point across. Regardless of the importance of his behaviors, however, there was relatively little significance given to them by the school staff. There had been no formal data gathered showing the frequency of the tantrum-like behavior, although these behaviors had occurred throughout the four years he had been enrolled in his current school. This would seem a telling indication of the educational system's ambivalence in addressing the area. Indeed, his fourth grade teacher expressed what appeared to be a common confusion among the staff regarding the misbehaviors. In this very interesting exchange, she is asked to compare Travis' misbehaviors with those of a nondisabled peer (T4, p. 14):

> PI Q: When we're talking about the misbehavior, the refusal to comply with whatever we're trying to get him to do, how does that compare to an 11-year old non disabled? Would it be allowed as much as it is with him?
>
> T4 A: I don't think the extent that Travis goes to would be allowed, but a non- disabled 11-year old could talk and tell us what he wants to do....and so for Travis, I think it [his behavior] is accepted because that is his biggest form of communication is his physical and .. his physical abilities. I mean another kid would say "I don't want to do this", Travis will hit you –it says the same thing, but I think it's fine if he wants to do that.
>
> (note: PI = principal investigator T4 = fourth grade teacher)

Many experts in the field of communication theorize that maladaptive behaviors represent communicative intent (Mirenda, 1997, Baumgart, Johnson, & Helmstetter, 1990; Carr & Durand, 1985; Reichle, York, & Sigafoos, 1991), and are increased by the frustrations related to ineffective communication. Following this body of thought, Travis' misbehaviors were likely exacerbated by the fact that he could not negotiate or explain WHY he wanted to quit a particular task. Although he could communicate a global negative to indicate his dislike of a task, he was never able to communicate specifically what he was objecting to or why. Staff had an ambivalent attitude about the behaviors, and they did seem to attribute them to Travis' lack of ability to communicate, which they fully expected to be very frustrating for him (T4, p. 14; OIS, p. 5). That confusion may have contributed to the overall inconsistency in the responses that followed Travis' misbehaviors.

Unfortunately, there was often little effort made on the part of his care-givers to help reduce Travis' frustration by expanding his communication methods, especially in the computer-based sessions. This was clearly evident in the inconsistency of efforts to ensure that he had physical access to augmentative devices or his alternate system of picture icons. Analysis of videotaped "work" sessions at the computer show a great deal of frustration on Travis' part. His global sign for negative--the "finished" sign--was rarely, if ever, explored for any variation of meaning. The staff consistently interpreted it as "I'm finished, or I want to quit". Often, the sign was ignored entirely. Although there were small augmentative communication devices prepared specifically for use at the computer, and programmed with phrases like "I want to change programs", "I want to quit", "I don't like this", etc., the devices were usually out of his reach (see Figure 8). Thus, Travis was unable to use the programmed phrases that could have let him communicate his opposition, therefore alleviating some of the frustrations that result in maladaptive behaviors, or perhaps reducing the need to use the misbehaviors to escape or avoid the task at hand. Although a few people positively reinforced him for using the devices, he was more often being punished for using the only method of escape--the inappropriate behaviors---that has worked for him over the years. This failure on the part of school staff to provide consistency in their attempts to see Travis use appropriate communication most likely added to Travis' frustrations, and therefore increased the likelihood of maladaptive behaviors.

For a nonverbal child like Travis, issues of physical needs, visual difficulties, unknown cognitive abilities, varying expectations, tiredness or illness, discomfort in positioning, hunger, thirst, dislike, boredom, or any of a thousand different factors were likely in play without the staff ever being aware. All of those things another student might say, like "I've done this a hundred times", or "this is too hard for me", or "my stomach really hurts", or "I have to go to the bathroom", or "I'm dying of thirst"......... are just not available in his system of icons. He can't say "I don't like this", or "I don't like you", or "you're hurting me", or "your perfume makes me feel sick". He can't say "my back is spasming", or "this stander is pinching my leg", "my arm won't work right", "I can't see that", "I can't reach that", "what is that?", "I don't get this", "I need some help", or "I want to play the program with the ducks". He can't negotiate to meet his needs, like "I'm so tired, can't I just rest first?" or "If I do this, can I get _____ ?". Some staff members suspected that Travis worried about issues at home, and that strongly affected his behavior (OIS, p. 6; T4, p. 3). Unfortunately, there was absolutely no way for him to talk about that or ask about his family.

A lot of nonproductive energy was being used to try to get Travis to cooperate with task requirements that he did not wish to perform. The staff had no way of knowing why he wouldn't cooperate, and, in the traditional manner, were attempting to arrange conditions to increase his cooperation (extrinsic reinforcers, lessening of distracters, mild punishments like "time-out" or scolding). Staff members responded in various ways to his distress. Some sympathized (VO #35), some attempted to physically maneuver him

(VO #4). The same person at times became annoyed (VO #32), and at other times ignored the behavior completely (VO #14). All in all, there was no consistency in the manner that the staff reacted to Travis' oppositional behaviors.

In conclusion, although a large amount of technology was used in Travis' educational environment, his communication system was not effective enough to consistently relieve the frustrations that overwhelmed him at times, and resulted in a display of inappropriate behaviors. Travis experienced a great deal of frustration when he was unable to communicate his wishes, and his behavior degenerated as he was unable to control his own actions. This became even more aggravated in situations where task requirements were imposed, as with the computer-assisted learning sessions, where the struggle was often played out to extremes. He may have had many valid reasons to object to conditions and requirements that were imposed upon him, but he had no effective way to communicate those. Despite these factors, Travis responded positively to well-planned learning activities and teaching strategies designed to increase intrinsic motivation.

Key observations are summarized below:

1) Travis repeatedly displayed significant maladaptive behaviors during many structured computer-based tasks, and those behaviors interfered with learning and performance.

2) Communication opportunities were limited throughout the sessions, increasing the probability of maladaptive behaviors. Augmentative communication devices and low-tech picture icons were available, but rarely were within Travis' reach (devices 10.5%, picture icons 25.5%). No devices or icons were within his reach for nearly 75% of the total time he was

videotaped (see Figure 8). Even when the tools were within Travis' reach, their use was very inconsistently reinforced by staff.

3) On-task behaviors at the computer, along with cooperation and effort, were increased in sessions where curricular tasks were neither too low or too high. Those behaviors were increased during sessions that contained specific teaching techniques—direct instruction and monitoring of needs, appropriate feedback/reinforcement, challenge, curiosity, control/choice-making, and recognition of communication attempts. Oppositional behaviors were decreased at these times, most likely due to increased intrinsic motivation and/or increased communication opportunities.

It would seem that a systematic analysis of behavioral antecedents and reinforcement is needed. With proper analysis, it might be relatively easy to find and verify methods that are successful in increasing Travis' intrinsic motivation for various learning tasks and reducing the maladaptive behaviors associated with restricted communication opportunities.

The Impact of Technology on Travis' Motivation

Motivation has been defined as an individual's desire to pursue and engage in a particular activity. Behaviors displayed upon approach or while engaged in a task can indicate one's motivational disposition. Maehr (1982), for example, described behavioral patterns he called indices of motivation. These include the direction of an individual's attention and activity, persistence, activity level, continuing motivation, and performance. According to Stipek (1988), behaviors that are associated with high achievement motivation include a willingness to approach a task or activity, a display of enthusiasm, happiness, pride, or eagerness, a maintaining of attention, a tendency to persevere at a task until finished or to solve problems rather than giving up, and a willingness to try again when faced with frustration or failure. To examine Travis' motivation for particular types of activities, a search for examples of these behavioral indicators was undertaken.

Observations on Travis' Motivation

Although Travis could not verbalize what motivated him, observation of his behaviors provided a world of information about his motivation for any given task. A close examination of Travis' behavioral reactions to various types of tasks was pursued. To begin, participating staff members were interviewed concerning what they thought was most motivating to Travis (in his educational day), or what he seemed to enjoy consistently. "Computer" was the overwhelming consensus (PP, p. 3; T4, pp. 1-3; OIS, p. 4). He also enjoyed listening to music, and controlling the tape player/radio with a switch.

Autonomous computer use was indeed Travis' most highly preferred activity. He consistently chose it from his "choice board" when he was given the opportunity to direct his own activities, and even though he often objected to assigned activities on the computer, during his leisure time he seemed to enjoy this activity more than any other and he asked for it repeatedly. During his free time, when he was allowed to control his own interaction with the computer, he was perfectly happy and the oppositional behaviors that were seen in structured learning activities were nonexistent. He was free to explore at will and indulge his very short attention span, often indicating he was "finished" with a program before it even finished loading (VO #8; VO #10; VO #14; T4, p. 8; OIS, p. 4).

The behavioral indicators of motivation, as defined by Stipek (1988) and Maehr (1982), show significant variations when applied to Travis' performance on different types of computer-based activities. It was quite obvious that Travis was not motivated to do certain types of computer-based tasks, and conversely was extremely motivated by the computer under different circumstances. As described previously, his*willingness to approach the task* of typing words, for example, was strongly and consistently nil. He always approached free-time on the computer, though, with great *eagerness,* asking for this activity repeatedly over time. *Focusing and maintaining the direction of his attention,* which was referred to as on-task behavior in this study, showed great variances depending on the task undertaken. *Time on-task* was clearly increased by certain teaching strategies, such as direct instruction (as discussed in both the Behavior and Achievement sections of this document) and relevant, challenging assignments. In the summer setting, when assignments were made but his performance was unmonitored, his time on-task was very, very low, and his attention was usually spent attending to other events in his environment. Travis' willingness *to persevere* at a task and willingness *to try again* were low in both types of settings (structured and free-time), when he was left unmonitored. However, as reported in the Achievement and Behavior sections of this document, both of these behaviors increased when teachers applied techniques such as direct instruction, monitoring of needs, and use of interactions designed to enhance challenge and curiosity.

Certified teachers were much more likely than non-certified staff to promote these techniques. They also used techniques designed to increase Travis' perceived control of the environment. For example, teachers who gave him choices about the software were attempting to increase his feelings of control. Those who directed him (verbally) to move the joystick or to stop clicking (VO #25; VO #34; VO #36) were met with far greater cooperation, on-task attention, and perseveration, as compared to those who picked up the joystick or switch and moved it out of his reach (VO #24), or those who attempted to physically maneuver his hands, holding them still or placing them on the switch or the correct letter (VO #3; VO #6; VO #8). As mentioned in previous sections, teachers who honored Travis' communicative attempts also saw far less oppositional behavior and more time spent on task than those who ignored him or failed to provide access to the tools he needed to communicate appropriately.

The same issues are revealed in regard to Travis' use of augmentative communication devices, where the difficulties involved closely parallel those involved with structured computer use. Travis' behaviors consistently indicated that he was not motivated to use more difficult augmentative devices--those that require training and practice to operate. Willingness, engagement, persistence and effort to learn operation of the devices were absent. Any serious attempt to require his cooperation was met with escalating oppositional behavior. However, he <u>was</u> willing to use the low-tech icons and simple switch-based loop tapes, perhaps because they were easy and immediately effective, and did not require large amounts of attention and perseveration to master.

It's not that Travis didn't have the ability to persevere when he wanted. Taped observations over the school semester, in fact, show remarkable displays of determination at times. Travis showed great persistence in learning to perform tasks of his own choice, such as walking with his walker, learning to transfer in or out of his wheelchair more independently (VO #16), or moving the mouse or joystick on the computer (VO #36; T3, p. 5). These strong behavioral patterns might lead to speculation that he was highly motivated by independence, autonomy, and control of his own environment. Indeed, these themes are repeated throughout this investigation. His fourth grade teacher described a young man who was searching for independence:

> ".... he also loves his free time, when he's in control of his situation, when he's in control of his environment, he loves going working on the computer, he loves listening to music........ just anything that he can do on his own...." (T4, p. 2)

Travis' third grade teacher also said that he "appreciates having tasks that he can perform all by himself" (T3, p. 3). In her classroom, he consistently asked for computer use when given a choice. This teacher encouraged him to work on the computer independently, with adults monitoring, but not directing (T3, p. 3). Interestingly, both she and the paraprofessional described his use of the computer at a higher level of operational skill as was observed a full year later. They both insisted he could use skills such as pressing zero on programs to exit, getting into other programs, and moving the mouse to activate a program independently (T3, pp. 3-4; PP, p. 7).

<u>Discussion and Conclusions</u>

Intrinsic motivation plays a very large part in Travis' behaviors and school performance, and it is very apparent in the extreme differences in his behaviors while performing various types of tasks. On computer-based tasks, there is a very noticeable difference in Travis' motivation and related behaviors when he is using the computer autonomously, as compared to those situations where an adult is trying to force him to do something he doesn't want to do. His behavior under each of these circumstances is as different as day and night.

Travis' intrinsic motivation was also affected by the structure and techniques used by teachers during instruction. There were very large differences in his motivational response to various types of teaching approaches. The teachers who used techniques designed to increase intrinsic motivation created activities that were much more successful in meeting the performance goals they had set forth for Travis. When approached with challenging tasks that stimulated his curiosity and perception of control, he was far more willing to cooperate, attend to a task, and persevere throughout completion of the task.

In this way, Travis is just like his non-disabled peers. All students are more likely to approach or persist in a task that is optimally challenging (Malone & Lepper, 1987; Stipek, 1988). It is inherently satisfying for humans to feel their competency increase (White, 1959). However, to experience this feeling, task difficulty must be neither too high or too low (Harter, 1974) in relation to the student's own skill level. Tasks that present challenges high enough to be moderately difficult, but not so hard that the learner is unnecessarily frustrated, are those that increase a learner's internal motivation. During the summer, when Travis was repeatedly assigned the repetitive low-level software, his behavior indicated a very low level of internal motivation. He rarely looked at the software, and spent his time almost entirely off-task. However, because it was so easy for him to just keep clicking the mouse with no real effort, he simply used the task to meet his own goal of being left alone to watch events in the classroom while pretending to be engaged in the software activity. Unfortunately, this behavior seemed to satisfy the staff, and he was positively reinforced for "working hard", even though there was no real learning involved.

The task of typing words, on the other hand, was no doubt too difficult for him. Developmentally, he was not ready to "write" words--no more so than a younger child who does not yet recognize the letter names or sounds made by the letters. Additionally, typing was physically difficult for him, as were most of his computer-based tasks. The typing task, as with many of his assignments, held absolutely no relevance for him. Travis' goal in computer use was mastery of the mechanics of the device. He simply had no investment whatsoever in typing words, and this lesson held no challenge, no fun, no reinforcement. Learning to spell and type were goals of the school staff, not Travis!

It is interesting to observe the significance of the works of Malone & Lepper (1987), who suggested that intrinsic motivation would increase with the use of strategies designed to enhance challenge, relevance, goal-setting, curiosity, and control for students working in the microcomputer setting. For example, when assigned tasks were *appropriately challenging*, not too hard or too easy, Travis showed an immediate increase in attention.

Malone & Lepper's theory held true on every point. When Travis' own goal of independently operating the input device was paired with an instructional goal, for example, the activity held more relevance for him, and there were much greater displays of motivation. The speech pathologist who had him practice moving the mouse by using her fingers as a guide succeeded in meeting the educational goal of learning vocabulary paired with icons. This same technique was successfully employed by the teacher who helped him use the joystick while working on concepts of big, middle, and little (VO #36).

Goal-setting was used to influence Travis' internal motivation. Those staff members who used the timer and instructed him to "work hard" or "work until the timer goes off" saw little cooperation. However, those who defined his criteria for completion, as with "you have five more to go", or even the more immediate "we've got to get him some big shoes" were purposefully setting small, well-defined goals for Travis, and seeing far more cooperation and perseverance.

Curiosity was used to increase his motivation. For example, the teacher who asked him "what will happen?", "what should we do?", and "how do we get the helicopter to go up?" saw one of the most successful sessions during the observation period.

Control, however, is probably the major factor that drives Travis internally. On the whole, he was far more cooperative with those teachers who recognized his communicative attempts to control his environment, who responded to his "finished" sign (even though they did not permit him to be "finished", they did acknowledge the communication by responding verbally). These teachers used a technique of "perceived control", allowing Travis to choose the program, make choices within the program, and indeed "choose" to behave or misbehave. Teachers or staff members who, albeit inadvertently, reduced Travis' control over the environment by holding his hands or moving equipment away from him (so that he could not give the 'wrong' response) were often met with extreme oppositionality. Far different were his cooperative efforts for those who asked him to stop clicking the mouse, for example, or instructed him to put his hands down.

Intrinsic motivation is clearly a key factor in technology use for Travis. Travis' mother gave an important piece of information concerning the issue of motivation, when she said:

> I think Travis can do anything he decides he wants to do, the problem is getting him to decide that he wants to do it.... like walking with the walker backwards and forwards, using the mouse on the computer. When he sets his mind to it, he can do anything he wants to do, but he has to decide he wants to do it first. (MO, p. 8)

And indeed, what Travis (or any human being) will do when he wants to do it is far different from what he will do when he does not want to do it. He can be very determined either way.

It is understandable, from the perspective of a student who desperately desires to control his own actions and establish independence in functioning, that he would not want to relinquish what little amounts of control he has found in the computer environment. He can have some fun, after all, when he has control of the computer. It does do things, in response to random presses and inefficient movements of the mouse or joystick--things that are large, colorful, and entertaining. And he is able to manipulate objects on the screen much more accurately than he can manipulate objects in real time. While he cannot push a toy car across the room, he can sometimes make it travel across a "room" on the computer screen, just by pressing a button repeatedly on the computer. Even though he often operated it inefficiently, the computer still provided him with entertainment and feelings of control, much like an electronic toy with pretty colors, sights, or sounds that are activated when the knobs or buttons are pressed.

It would seem that all of the effort made by staff to control his behavior at the computer was at direct odds with a major drive within Travis to control his environment and his actions. Travis was deciding what he wanted to do. Although he occasionally was willing to cooperate for reinforcers (or perhaps pretend to cooperate), he basically was refusing to do what he did not want to do, thereby exerting control over his life.

Unfortunately, these conflicts interfered strongly with the educational staff's desire (and obligation) to instruct and provide learning opportunities for Travis. Large amounts of his "instructional" time were wasted while just randomly pressing a switch to meet minimal behavioral requirements such as "work well" or "keep clicking", or by fighting with staff to recognize that he did not want to participate in an assigned task, perhaps for very valid reasons, albeit those that he cannot verbalize. While Travis' oppositional behaviors may have been based on a strong drive for control and independence, he was not using the programs appropriately or effectively for a large percentage of the time that he was at the computer. Using the computer for direct instruction, practice, and learning of curricular skills (such as language development, or number and money concepts) were not particularly relevant to Travis, and he opposed being required to perform those tasks. He was not willing to put forth the effort to persevere and maintain his attention long enough to learn how to effectively operate more difficult computer programs and more sophisticated augmentative communication devices. Those and other benefits that the computer might provide, such as to serve as a voice prosthesis, powered mobility, or environmental control, were thus prevented by Travis' lack of cooperation.

Observations showed clearly that Travis would cooperate, engage, and persist, for the most part, only on tasks that were relevant or interesting to him. Because of limited communication opportunities, he could not negotiate his performance like other children, and because he was so limited in what he could do, traditional reinforcers held little value for him. However, when techniques that enhance intrinsic motivation were used, his performance and behavior did improve. To increase Travis' interest in performing traditional tasks at the computer, he will likely need to become more aware of it's potential relevance. Internal motivation will have to be increased before he will persist in more difficult learning tasks. This will require, from the educational staff, additional emphasis on those techniques that were shown to affect his participation.

In conclusion, technology and motivation are interrelated in the education of Travis, affecting each other in a circular manner. Major findings are summarized as follows:

1) Travis was strongly motivated by independent use of the computer. Although unassisted use of the computer was often unproductive in meeting educational goals, he continued to enjoy it immensely.

2) Technology increased Travis' ability to exert autonomous control of his environment, and his motivation was strongly related to his ability to control various tasks. Technology added an element of independence into both of his two most preferred activities, i.e., computer play and listening to music/books. He was able to operate the tape player/radio much more independently through use of the switch-activated unit, and he was able to interact with the computer in a more independent fashion when using special software and input adaptations.

3) In technology-based work sessions, Travis' internal motivation, as expressed by time on task, level of engagement, interest, and perseverance, was increased by strategies designed to provide a well-

structured task, such as direct instruction and monitoring of needs. Strategies used to increase internal motivation, i.e., use of choice-making, challenge, relevance of the curriculum, goal-setting, increasing perceived control, and recognition of communication attempts were also met with noticeably better cooperation, perseveration, and attention to task.

Travis' goals regarding use of technology were set by Travis, not the adults around him. Using the computer to meet the goals of others was NOT relevant to Travis. He wanted to be in control of the computer environment, even though the problems that he had with access (not being able to accurately or quickly move the mouse, etc.), together with his lack of internal motivation, were inhibiting more effective uses of the technology. Unless there are active strategies to increase internal motivation for tasks that Travis does not enjoy, he is likely going to continue to fight to maintain control of his actions, and he is likely going to win that fight.

The Impact of Technology on Self-Esteem

Self-esteem refers to judgments about one's own worth and beliefs about one's own abilities (Marshall, 1989). Measuring changes in self-esteem, like motivation, is a fairly subjective task, one that relies heavily on self-reported feelings and attitudes. Traditionally, evaluative tools ask participants to respond to statements such as "I am a happy person", "I give up easily" (Piers-Harris Children's Self-Concept Scale), or "most of the time do you find it useless to try to get your own way at home?" (Nowicki-Strickland Locus of Control Scale for Children). This type of measurement would be highly inappropriate for a child with impaired language skills.

Even though he might be able to give an answer (via assistive technology), one would not be able to judge his comprehension of the questions themselves. Thus lies the inherent difficulty of evaluating in this area, in an attempt to provide an accurate measure of Travis' self-esteem. How then, would one go about discovering the impact of technology on Travis' feelings about his own self-worth? To begin exploring this rather subjective area, information was gathered from those who were most closely involved with Travis.

Observations on Travis' Self-esteem

When examining the perceptions held by significant others regarding Travis' self-esteem, there was strong consensus that technology had a positive effect. Travis' mother thought that the use of technology was related to gains in his abilities to do things "like the other kids", which she thought made him feel less different and more happy. His third grade teacher thought that technology decreased his frustrations, causing him to feel better about himself. The paraprofessional said that he grew as a person "about 300%" as he began to have more control over his environment. Table 4 shows direct quotes of each interviewee.

Although the perceptions of those closest to Travis gave some clues to his self-esteem, his own inner thoughts and self-judgements are still unknown. However, looking at the perceptions of those significant adults seemed to point toward several issues related to self-esteem. Those issues, ones that seemed so important to Travis, were related to self-efficacy, competency, and control of his own actions. To better determine his feelings about himself, a search was undertaken for clues in Travis' behaviors related to areas of competency and control.

The drive toward competency is an important component of self-esteem. White (1959) speaks of the intrinsic, innate "need" to feel competent. Self-esteem develops as one is able to explore their environment and develop mastery and control over one's environment. As one explores the environment and becomes competent in small ways, feelings of self-esteem grow and become positive. Self-efficacy, or a person's evaluation of their ability to perform a particular task, is closely related to a person's feelings of competency (Bandura, 1981), which correlates with positive self-esteem.

Travis showed many indications of a child who has a strong desire to gain and then demonstrate competency (VO #12; VO #17; VO #19; T3, p. 13; OIS, p. 4). As described below, significant others saw behaviors that indicated his preference to try to do things himself. When faced with help that he did not want, he would object strongly, expressing his desire to control his own behaviors.

> Ms. H: "Trav, go to your chair, it's time to get to art". He crawls over—uses left leg and slides on knee of right. He moves his walker out of way and goes for his chair. Ms. H. tells him to get a little closer, and to get pulled up. She thinks he is stuck, but he's not. He gets up on knees. The paraprofessional comes up and prompts him. He objects quickly and loudly. PP: "I'll wait". **He wants to do it himself, and tries.** The para approaches again and **Travis objects loudly.** He is telling her "go away". He attempts to pull up, she grabs him and gets his right foot up on the pedal. She boosts him up into the chair and straps him in. He doesn't look too happy.
> (edited video notes, 10-2-97)

Travis showed this desire to demonstrate his competency in many small ways. For example, he loved being videotaped, and he would try harder when the videotape was rolling. Indeed, this study is replete with evidence that Travis was highly motivated by "showing his stuff" (VO #8; VO #17; VO #18). His third grade teacher stated that Travis "liked to show you what he could do - he got very, very excited about showing off" (T3, p. 7), and that was apparent in the huge smiles that occurred when he saw the videocamera. He seemed to work hard for the camera, and, if misbehaving, would cooperate momentarily when reminded that his Mother or someone else might see the tape (VO #28).

Table 4

Opinions of the impact of technology on Travis' self-esteem.

T4	Yes, I think that technology lets him be more independent, more in control in what he's doing in his environment... and I think that helps his self esteem a lot.
PP	Yes, a very large impact. .... If I had to estimate a personal growth level, I'll bet you he grew as a person about 300% over the years when nobody expected anything more than what they saw with their physical eyes.
T3	I definitely do - I think he was feeling so much better about himself ...... He liked to show you what he could do - he got very, very excited about showing off.
MO	A great deal, ... For a long time during the first year we were here especially, I didn't see smiles, he seemed depressed to a certain extent. As he has grown in his ability to do some of the things the other kids can do, it has given him the ability to be like the other kids and that is very important.
OIS	He's proud of anything that he can accomplish – if he prints something out on computer, you can tell he really feels good about it, he smiles so big, and really is intent to get the paper and put it in his backpack. He loves to show that stuff to his mom, I think. About communication – no, I can't think that he is proud or thinks he is accomplishing something. He just wants things, or wants his way, and he is willing to use icons or something to get it if he has to. But it doesn't make him feel any better, like using the computer does sometimes. Except for maybe the looptapes, he does seem really proud when he has a "story" to tell, he will tell it to his classmates in regular classes, and you can see alot of pride there.

Key: T4 = Fourth grade Sp Ed teacher. PP= Paraprofessional. T3= Third grade Sp Ed teacher. MO=Mother. OIS = Orthopedic impairment specialist/teacher.

Feelings of competency are related to another important component of self-esteem--the sense of personal control (Harter, 1983). As children grow, the ability to control their own environment becomes increasingly important in the development of feelings of self-worth. One might speculate that Travis feels a strong sense of personal control while using the computer under his own terms, and a loss of control when he is being forced to perform a task that he did not initiate. DeCharms (1984) theorized that students who feel they are participating in learning activities by their own volition ("originators") are more likely to persist at tasks, complete tasks, and make gains in achievement levels than those students who feel they have no control over assigned tasks ("pawns"). Thus, as discussed previously, on assigned learning tasks, especially ones that he does not like or does not feel successful with, Travis asserted his ability to control the situation by refusing to do the task. Staff members who sought to "control" or force him to participate were met with even greater determination.

Self-esteem issues can also be observed when considering Travis' unrestricted use of computer. His computer use during freetime, on the surface, appeared to be no more productive (learning-wise) than the repetitive, unmonitored computer tasks of the summer session. If anything, he attended for even shorter periods of time, a behavior which frustrated and mystified the staff. He rarely focused on a program for long when given control of the computer. Under these circumstances, his attention was more directed to jumping in and out of games and getting other people to change games for him. Travis delighted in getting staff members to set him up at the computer and help him load a program. Then he would sign "finished" before ever attempting to play with the program (VO #8; VO #10; VO #14; T4,

p. 8; OIS, p. 4). Because of this unwillingness to persevere at a task of his own choosing, one might speculate that he may have been enjoying the ability to direct others more than the actual computer use. Indeed, at these times, his ability to direct humans was much more effective than his ability to effectively direct the computer. For Travis, control and self-esteem issues seem to be inextricably intertwined.

Independent control of his environment and self is a critical piece of the puzzle that is Travis. He did not like to be told what to do, a fact stressed repeatedly by teachers and staff. Unfortunately, his goals were often in direct conflict with those of the educational staff. On computer, he was concentrating on controlling the computer-- moving the mouse, getting in and out of programs, printing out "work". He felt successful and in control while performing these tasks independently. Travis had no investment in performing to "win" the game, or to complete the curricular component of the software programs. He sought growth on his own terms, resulting in an increase of feelings of competency and self-efficacy. He was not interested in the computer-based goals of the adults. In his never-ending struggle for control, he rejected being put in the position of "pawn", where other people were pushing him around (instructionally), and insisted, via his oppositional behaviors, on being an "originator", or a learner who initiated or controlled his own actions.

Discussion and Conclusions

By all accounts, Travis was a fiercely independent young man. He had distinct preferences and expressed his desires strongly. He appeared to know exactly what he wanted and what he did not want (as opposed to the adults and peers around him who often seem confused). He often wanted to try to do things for himself, and became irritated and angry when offered help that was unneeded or unsolicited. Was this "determination" a measure of self-esteem? Did Travis believe in himself, and his ability to do many things, or that he could learn to do many things through persistence and practice? It would seem so, but only on tasks that he chose for himself.

The amounts of control afforded Travis may seem small to those not experienced with his world. However, the fact that he is using some technology-based tools to increase control of his environment, and that he has developed the ability to say "NO" and make it stick, is really a quite strong internal position for him. He has shown the school staff that he has the ability to control his own life, to make his own decisions, and that he has the potential and the will to use whatever means are within his power to create more autonomy and independence for himself.

How did technology relate to those feelings within Travis? Key observations are summarized for the reader as follows:

1) Technology-based materials and systems in the classroom had some effect on Travis' ability to make choice and determine his own actions. He used his picture icon system to give himself more situational control, such as a choice of which assignment to do next, or which type of snack he preferred.

2) Travis was able to operate equipment more independently by use of computer adaptations and switch-activated environmental control equipment. He also used computer free-time to control the behavior of staff members, by constantly requesting they change programs for him. More autonomy in these areas seem to have enhanced Travis' feelings of competency. Theoretically, increased feelings of competency result in a more positive self-image. This was verified by those closest to Travis, who felt that

technology had a positive effect on Travis' self-esteem.

3) Issues of control, self-determination, and competency play a critical role in Travis' daily interactions in the educational setting. These issues take on new importance in congruence with Travis' newly developing abilities to effectively use technology to increase his own feelings of self-efficacy, competency, and control. Theoretically, increases in these areas should positively effect Travis' self-esteem.

Impact of Technology on Peer/Social Interactions

Did technology have an effect on Travis' peer and social interactions? Was technology used to facilitate Travis' inclusion into the least restrictive environment? An examination of the role of technology in peer relationships and social or interpersonal interactions (in both in lab and regular classroom) was undertaken.

Observations on Travis' Peer/Social Interactions

Travis seemed to prefer to spend most of his free time in activities that could be performed independently. He did not often play or interact with peers from the fourth grade classroom. Travis did use technology to choose activities for leisure time by using his icon board to indicate activity choices (T3, p. 1; PP, p. 2; VO #24; VO #36), but the choices did not usually involve peers.

To increase his social interactions, the educational team had identified two goals related to these areas. i.e., playing games with a peer, and having peers visit in his Special Ed lab once a week (Doc #2, p. 9). Information was somewhat conflicting regarding the impact of technology on these issues. For example, throughout this study he was never observed playing board or card games with peers, and was observed only once playing imaginary games or any other kind of games with peers (VO #19). Travis reportedly preferred to watch others play games (T4, p. 3), occasionally engaging in a "helper" role, such as tossing out cards (T4, p. 12).

The ability to play computer games with his peers, however, was regarded by adults as an important and unifying phenomenon (MO, p. 5; PP, p. 6; T3, p. 9). Surprisingly, though, Travis was not observed attempting to play computer games with peers, except when directed by staff. There were two observations of attempts to play a computer game with a peer during the sessions. Both times, the game was assigned and presided over by a paraprofessional, who seemed to have no idea of what was really happening on the screen. Both times, there was little engagement or intent observed on the part of either he or his "partner", another student with disabilities chosen by the attending staff (VO #3; VO #5). While free-time computer games were reportedly an important and regularly occurring social event in third grade, they were not observed or reported in fourth (PP, p. 7; T4, p. 12).

The impact of technology in social interactions was most obvious in an increased ability to communicate with his peers. There was some increase noted in interpersonal interactions in the inclusive setting, mostly related to his expanded ability to communicate. Most communicative interactions, however, were in response to prompts or questions, and rarely were initiated by Travis, who relied more often on no-tech actions (gesturing, pulling, pointing, expressions, etc.) to engage with his peers with disabilities. He was, however, able to share stories with those classmates via switch-based recordings, and was included in class plays and parties.

For the most part, technology seemed to have little effect on his peer interaction or inclusion in fourth grade classroom activities (T4, p. 12). Travis was "included" for an hour daily, at which time the teacher read aloud to the students. During this activity, there was no talking or discussion allowed. Although he did have his icons on the belt and wheelchair tray, he had no augmented devices, chime alert, or yes/no switches. Interestingly, Travis "made noises" a great percentage of the time in this class (T4, p. 10; field notes, 11-18-97). He made low growling or guttural noises that were not unpleasant, but which might last for several minutes at a time. The teacher and kids generally ignored this behavior, which was not observed or reported at any other time in his entire school tenure. This period of time when Travis was "included", for the most part, did not allow for social interactions, and social interactions were rarely observed during the scheduled or nonscheduled observations.

Discussion and Conclusions

Travis' peer interactions were somewhat limited by the large amount of time he spent in the special education classroom, where he chose not to interact much with the other children. Most of his interactions were with adults. During leisure time, he made good use of technology in both choosing activities and using free-time materials. Perhaps there was a circular relationship between those two phenomena, with Travis having chosen those particular activities because they allowed him more independence. The "choice board" provided a way for Travis to self-direct his own social interactions and to exhibit some control over the amount and kind of participation that he desired in events around the school. Travis, however, rarely chose to play with other students, and it seemed that his preference was for activities that did not require social interaction.

An interesting polarity between adult opinion and observation occurred with computer games. Because opinions were so strongly stated in regard to the almost magical opportunities for Travis to play with his peers afforded by computer games, one might speculate that there had been successful interaction in this area previous to the study. Indeed, staff who worked with Travis in third grade reported computer games to be an important phenomenon in the inclusive setting that year (PP, p. 6; T3, p. 2, p. 5). Travis' mother, who was interviewed between his third and fourth grades, also felt that computer games were an important factor with peers.

> ......I think the difference is the technology where he can do things with them where he can't run and play ball with them, he can punch the computer keys or move the mouse so they are actually playing with him and that's what they want. (MO, p. 5)

Computer games, according to the adults around Travis, provided a virtual meeting place, as opposed to the school playground, for example, where he was much more limited in mobility and ability. In this way, the computer became a figurative 'playground' where Travis could play with other kids, at least in the expectations of the adults around him. Perhaps because the computer had provided, at some point, Travis and his same-age peers a way to play together in an environment familiar to both, they became more like equals in the eyes of others.

This brings up an interesting issue. Were these descriptions of computer game interaction merely idealistic longings, perhaps "technology myths", or was there some basis for the glowing perceptions of adults regarding the power that computer games had on Travis' abilities to use this format to interact with his peers? Or was it the situational conditions, unique to that setting, that prohibited this type of play? Certainly, at no time in observing Travis in the "regular" fourth grade classroom, would this type of play have been encouraged or allowed. There is no data from this study that would support either proposition, outside of the perceptions of interviewees who had contact with Travis in other settings, before this observation period.

While there was some increase in more "appropriate" or "understandable" interactions between Travis and his peers, the actual quantity or type of interaction with others seemed little affected by technology or the communication system developed for him. Travis did interact with others regularly, although a lot of times in ways that were inappropriate or difficult to understand. He tended to use gestures, body language, pointing, or pulling on other kids' clothing to gain their attention. Uses of his technology-based system were rare, however, in Travis' situation, almost any increase in symbolic communication reflects growth in successful social interaction.

Technology use, especially computer use and use of a communication system, holds great potential to improve both the quality and quantity of peer interactions, and increase the amount of participation a student has in inclusive settings. However, this participation can be affected by many factors, such as the availability of devices (as discussed in the Communication section of this document). It can also be affected by factors relating to the quality of the setting, and the knowledge and desire of adults in that setting to see an improvement in the student's interactions. When the student is "included", for example, in a daily activity where peer interaction is limited-- is in fact, inhibited, as was Travis' case in his fourth grade inclusion experience, it is unlikely that opportunities for peer interaction are going to increase.

In conclusion, the impact of technology on areas related to social issues in Travis' education are summarized as follows:

1) Technology had a limited effect on social interactions, except in the area of communication. There were increased opportunities for sharing information and responding to others via the communication system.

2) Adults felt that computer games were an important peer activity for Travis, however, observation did not support this perspective.

3) In the special education classroom, Travis interacted far more with adults than with other children. These relationships revolved around assigned activities and educational/self help concerns.

4) There was little peer interaction in the inclusive setting, where opportunities for social interaction and communication were limited. No daily use of communication tools or other technology was observed.

Impact of Technology on the Expectations of Others

Did the use of technology have an impact on the attitudes, beliefs, or expectations of significant others in Travis' educational setting? In Travis' world, was there a change in their ideas about his abilities when he used new tools successfully?

Observations on the Expectations and Goals of Others

Virtually all of the participating adults believed that the use of technology had a noticeable effect on the attitudes and expectations of Travis' peers, with the computer especially providing a way for them to play together. For example, his mother said "Where he can't run and play ball with them, he can punch the computer keys or move the mouse so they [peers] are actually playing with him" (MO, p. 5). The paraprofessional who often worked with Travis in his regular classrooms also felt the computer was a tool that helped peers know how to interact with him, drawing them together and creating a bond. His third grade teacher, talking about the effect the communication cards had on kids, teachers, and parents when there were classroom parties or events, stated:

> It was very helpful for people to be able to have basic communication with him. That really showed people how smart he was because at least he was able to convey that.....by using [picture] cards. (T3, p. 6)

She felt strongly that his use of communication boards and computer use altered the way that people thought of him.

> I definitely think that people see Travis differently [before demonstrating an ability] than you do after you witness him reading and retaining words......I think everybody who would see Travis work would be sort of surprised at first if they had a preconceived notion of what he could do.... (T3, p. 6)

The use of technology impacted the feelings that staff members had about Travis' capabilities. The physical therapist working on the educational team for Travis was quite specific in describing the way that technology impacted her own expectations for Travis' future.

> I think technology is going to be important in all his major life areas, including leisure, ...without those, he would be able to propel a wheelchair around short distances, at great expenditure of energy and

time, he would be able to walk or crawl within a room, but again time and energy and social acceptance would be factors for that...... I think I could just go through every area and say that he would be very limited in terms of function, self-care, and a rewarding, stimulating life [without technology]. (PT, p. 5)

She was quite insightful in describing the variance in expectation levels of staff members, and how those expectations affect Travis.

> There are problems that arise sometimes, in that some people don't push him or demand as much from him as what he can do, and like most of us, he's quick to pull back his performance level to that low expectation level. Equally difficult would be the situations where too much is expected of him, he tires, he gets frustrated, and has many people placing demands on him through the day. So expectation of performance and cooperation is an ongoing challenge for all of us. I think that probably a lot of the staff are at different places in seeing the role that the technology can play in the expectations, and that's one of those things that we're exploring, and it's going to be ongoing exploration, as to what could technology do for this boy. (PT, pp. 5-6)

The wide variance in levels of expectation among staff play out in their daily interactions with Travis. The beliefs that are held by individuals are spelled out in their interactions with him. Regarding communication, for example, people sometimes talked to him using babytalk (PT, p. 6), or got right up in his face and intruded his space (T4, p. 17). Others were described as not asking any questions, just making assumptions about what he wanted or needed. Often people would ask questions and not wait for an answer, as discussed below:

> So I think right now, his ability to communicate, make choices, participate in what's going on are sometimes limited by people's opinions about how well he can answer or whether he can answer, and if they don't bother to get his icons and put them where he can touch them..... if the aug. comm. is 20 feet away and you're assuming that he can't use it or won't use it so you never bring it within his reach,

> it's not going to help him. I think that that is an area that right now, everyone's working real hard on is getting communication in place, that same scenario could be played out with the computer or just about any assistive device, of any kind. (PT, p. 6).

Travis' ability to demonstrate skills was a critical variable in changing the attitudes and expectations of people around him. The classroom paraprofessional very clearly illustrated the role of technology as an evaluative platform and the resulting changes in her expectations (PP, pp. 6-7).

> PI Q: Do you think his knowledge of computers has had any affect on your attitude or ideas or expectations about what he can or can't do?
>
> PP A: I think it's reinforced them, because I had a feeling that Travis could do and was capable of doing lots more than what he was showing us he could and through the use of the computer, I was actually kind of able to test his boundaries, the ones that he had set for himself, and the ones that we had set for him.
>
> PI Q: Tell me more about that. Maybe you could give me an example.
>
> PP A: Well,..... We found out that he was capable of doing a lot more than he had shown us in the past ....When we weren't looking, how he would move that mouse. When we weren't looking, how he would choose programs that were a little more of a challenge than what we had been putting him on. And as we began to observe these little things, we began to put more expectations on him about what possibly he could do.
>
> (note: PI = Principal Investigator PP = Paraprofessional)

Indeed, a recurring theme in interviews pointed to the role that technology plays as a platform for evaluation of the students' capabilities.

People in Travis' life thought that the computer gave him a different way to write or read or talk, providing a way for people to see what he could do, and that, in turn, had a significant effect on their expectations for him.

OIS When I work with him on computer, I can see him responding correctly, or using some timing to get, to make something happen, and I have a much better idea of what he can do or what he can't. .... With Travis, it's hard to know what all he is understanding, but once you see he can do something, that helps you sort out whether it is that, or some other problem.. (OIS, p. 6)

T3 ...You could see how much he was capable of..... It was very helpful for people to have basic communication with him. That really showed people how smart he was because at least he was able to convey that so much by using [picture] cards.......I definitely think that people see Travis differently [before demonstrating an ability] than you do after you witness him reading and retaining words and retaining them and performing these, it definitely has an impact. (T3, p. 6)

Technology was also one of the main avenues for staff members to see what he could actually do, where his limitations really set in. Another teacher discussed the overall changes that had occurred in the staff's expectation levels (OIS, pp. 5-6).

PI Q: Do you think Travis' use of technology has had any effect on the expectations that adults have about his abilities?

OIS A: hmmmm.. oh I'd have to say, definitely. I remember there being alot of discussion, in fact there is still always alot of discussion about what Travis can do and what he can't do. But when he first came, some of the teachers thought he was really retarded, I think the general consensus has changed since then. I'm not sure if it's the technology, except that the technology, like the computer or the yes/no buttons, can really show you that he understands something. And when he uses a device to say "I want to change programs", or "I want a break", you can tell he really means that. If nothing else, it has shown us that he has definite preferences and that he really wants to make choices about things, that he has his own thoughts and ideas or opinions.

Travis' mother talked about the time he first came into the school district, and her struggle with staff to change their perceptions (MO, p. 5).

PI Q: Do you think that Travis' use of technology has had any impact on the way that teachers or staff feel about Travis' abilities? Were there expectations of his abilities?

MO A: Yes, definitely. The first few years we were here, I kept saying "he's really smart, he really knows this" and I kept being told, "he's not showing us". But, when he finally started using the technology the appropriate way and showing that he knew it, they started noticing what I had been saying, that he is smart and he knows what's going on and what you are saying to him.

Travis' mother felt very strongly that his use of computers and communication boards altered perceptions of others, and she did not limit that to educational staff.

> I think the first thing people see is that Travis is cute, big smile, big eyes, blond hair and then when they see he is non-verbal, they think in today's society that being non-verbal means being mentally retarded. Then all of a sudden they see that he can do something that shows that there is a mind in there working and then people perceive differently (Mo, p. 5).

She began to expand on the effect of the technology use on the family's attitudes, talking about his two little sisters, and how much less reticent they had become in their interactions with him. She went on to say, "my husband has come to realize that he is going to be something more than someone we are always taking care of. He knows he [Travis] is smart but when he sees him doing things it makes a big difference".

Discussion and Conclusions

What beliefs do people hold regarding a student like Travis? What expectations underlie interactions with him? What expectations are his daily educational goals based upon? When people speak to him, do they wait for him to answer, answer for him, or just simply keep talking without waiting for any kind of response? Does their interaction with him show that they don't expect an answer, as in "you want the red crayon, don't you? I'll give it to you, here you go"? Or does their behavior indicate an expectation of an answer, as in "do you want a crayon? (pause time) Which one do you want (pause time)?"? In their interactions with Travis, people constantly demonstrate the expectations that they hold. Among the people who come in contact with Travis in the educational setting, both adults and peers, there is a whole spectrum of beliefs. Some believe he can do certain things, others obviously don't.

One theme that is repeated throughout the interviews is this: When Travis can demonstrate the ability to perform a task, it drastically changes people's expectations for him. This phenomenon is not so different from all humans. When a toddler demonstrates that they can control their bodily functions, we begin to expect them to do so. When they begin to talk, we no longer accept crying and pointing. Technology serves a powerful function in the daily interactions of someone like Travis. Before Travis started using technology, he would smile for yes and do nothing for no, or maybe give the "finished" sign for no, and it was difficult to really know for sure what he meant. With the icons, it was also difficult, because he often seemed to be just pounding on his tray and not looking at the icons, leaving people unsure if 'that's what he really meant'. With the yes/no loop tape switches, however, there was very little doubt that he was answering a question, and answering it purposefully.

In conclusion, technology, because of its ability to "level the playing field" and therefore change expectations for a child like Travis, could be considered the single most important phenomenon in Travis' life. Although Travis is not using technology as fully as possible, its true strength lies in the potential it has for changing everything around him. The generation of children he is growing up with will continue to expand their expectations for him, as he is able to successfully demonstrate more and more of his abilities, rather than his disabilities.

> ....I do see the other kids watching him, and I want them to know he can do those things. The loop tapes, when Travis tells them something about his home life, I can really see it opening up their eyes. They do try to talk with him, but I think they need more help – they will just kind of breakdown, when he can't answer, maybe they asked too complex of a question, or something he can't answer with his icons, and then just kind of drift away. But I did have a few kids come up to me and say, 'I didn't know he could walk'. I think technology will change people's expectations of him more and more, especially if he comes to use it more to communicate (OIS, p. 6).

Assistive technology opens up the possibilities that Travis will be able to communicate more effectively, operate computers or other machines, gain independence in mobility, and accomplish an ever-increasing number of other tasks that he has thus far been unable to perform. As he begins to demonstrate new abilities, it changes people's underlying attributions for his behavior and increases their performance expectations for him. In Travis' life, we are beginning to see these changes in expectation levels among some staff members and peers. The end result of these changing attributions and expectations will predictably affect personal goals proposed by the team and implemented in the classrooms.

Successful demonstration of ability can change the attributions that people assign for various behaviors, resulting in an increase in performance expectations. Hopefully, as technology becomes more user-friendly and accessible to Travis, there will be fewer "breakdowns", better learning, and the end result will be a higher expectation level for all persons involved with Travis. To summarize, technology is showing the beginnings of what will no doubt become a profound and pervasive impact on the expectations of all others-- adults and children alike, who are involved in the daily educational experiences of children like Travis. Based on these observations, several themes were found in this study. These are summarized below.

1) Assistive technology positively impacted the attitudes, beliefs, and expectations held by significant others in Travis' life--peers, adult professionals, and family members. There was a particularly powerful effect when Travis demonstrated abilities or actions (via the newly accessed medium of technology) that were previously absent from his repertoire of behaviors.

2) While there was little evidence that technology use changed the goals on Travis' yearly IEPs, expectations of staff members, family, and others involved in Travis' life were played out daily in the small, immediate interactions in student life. These interactions were beginning to show some indication of changes in expectations. Technology, when used as a tool to assist more successful functioning, will continue to be a big part of those changes.

CHAPTER V: SYNTHESIS

The use of assistive technology has affected Travis' educational environment in many ways. For Travis himself, new pathways have been opened, providing the potential for him to perform tasks that were previously impossible. Before the technology existed, there was very little opportunity for him to participate in the typical tasks of schooling. There was no way for him to learn to count, spell, write, or communicate effectively. Now there is a way for him to do each of these things. Perhaps more critical to his educational program, technology provides the tools that allow people to be able to teach him how to do these things. Because now he can demonstrate his skill levels, educators can see whether he is learning, and what he is learning. This powerful new potential changes the very rules of the game, redefining the concept of "disability", expanding the boundaries of what children with severe disabilities can and cannot do.

The advent of assistive technology in the school system dictates a rethinking of the philosophies upon which educators base their treatment of children with severe disabilities. In Travis' case, although the actual measured gains in communication, achievement, or appropriate behaviors are small, the symptoms of change are beginning to show, and the school system is caught up in the need to change the ways they attempt to teach and interact with students who have severe disabilities, like Travis.

The Impact of Technology on Travis' Educational Program

Communication and computer use are the areas which showed the most significant impact in Travis' educational program. Technology use also impacted affective areas, such as motivation and self-esteem, and the expectations and beliefs of significant others were positively impacted by Travis' technology use.

Communication

The use of technology in an effort to expand alternative communication is an area where a significant impact on Travis' educational program can be seen. Before technology was used to create his alternative communication system, he had a severely restricted communication repertoire, one which was limited to only two types of global responses, i.e., a smile for positive and the "finished" sign for negative. To communicate a very strong objection, he would stiffen his body, throw his head back and exhibit facial expressions of anger and distress, emit disruptive, strident vocalizations, and attempt to hit the staff person with whom he was displeased. Now, with his alternative communication system in place, he has the ability to ask for help, ask to go to the restroom, quit a program, or take a break. He is able to answer yes and no questions more effectively and his communication partner can understand him more clearly. He is able to share information about himself with his peers, and to communicate objection and anger in a more appropriate and safe manner.

He has done each of these things to a limited degree. He was capable of using loop-taped messages, augmented yes/no switches, and small devices (with no more than four phrases), and would do so when prompted. For the most part, however, his use of all communication materials or voice-augmented devices was prompt-dependent, and he would fall back on his long-established methods of gestures, sounds, body language, and behaviors unless "reminded" to use the alternative system materials.

Although there were a number of possible reasons contributing to Travis' limited use of technology-based communication tools, the primary reason appears to be inconsistent physical access to those tools. As demonstrated by an analysis of the thirty-six videotaped observations, he was unable to reach any of those tools, either picture icons or devices, approximately 75% of the time. Additionally, reinforcement by staff of the use of the devices or picture icons was inconsistent, even when they were accessible to Travis.

Certified staff members were far more likely to reflect training or knowledge of communication training strategies, and higher expectations of Travis overall. Although not unanimous, the teachers were far more likely to keep the tools within his reach, to ask him to use the devices, and to recognize his communication attempts in general. Unfortunately, Travis was often supervised by non-certified staff, particularly in the summer school sessions, where access to devices or icons and strategies to teach alternative communication were practically nonexistent.

While it is difficult for teachers to find time for training, it is often not an option for noncertified staff. In this setting, my own personal observation has been that training opportunities, while occasionally provided for certified staff, are usually not available for noncertified workers. The paraeducators are usually left with the children while the teacher is being trained (or performing other noninstructional duties), and, because they are paid on an hourly basis, are not funded for training opportunities outside of the school day.

An effort within the system to expand Travis' communication is evidenced by the large amount of equipment and materials in the program.

Use of the devices and tools, unfortunately, have not been consistently supported in the classroom. Provision of the tools (keeping them within Travis' reach), along with provision of positive reinforcement for use of those tools, has not occurred consistently enough to retrain Travis' communicative behavior. Although the effort has had an observable impact on Travis' educational program, his current alternative communication system is only minimally effective. It seems that although there is an appropriate amount of technology available for use, the technology alone has not resulted in training Travis to use more acceptable measures of communication.

Implications for practice. Promoting the expansion of alternative communication for Travis is a task of monumental proportions, one that has only just begun. There are many things needed to advance the goal of functional communication for Travis, some of which include:

- a systematic analysis of Travis' behavior to understand the underlying communicative intent;
- consistent reinforcement, or at least acknowledgement, of Travis' alternative communicative attempts;
- goals for communication training that are understood and accepted by all staff who work with him;
- training, information, and time for staff to discuss and question the use of new tools and strategies. Paraprofessionals and teacher assistants must not be left out of the training experience, and this training should not occur at the expense of other students or non-instructional duties; and
- more information is needed regarding the limitations of Travis' physical capabilities to assist caregivers in determining accurate attributions for Travis' behaviors.

Computer Access and Use

Learning to use computers for instruction, recreation, and assistance is an ongoing effort in Travis' educational program. A variety of adaptive input systems have been tried, over the years, in an effort to provide an effective way for Travis to input answers or choices into the computer. Although he has shown small gains in his physical ability to maneuver a mouse or joystick, switch use is still his most effective method of operating the computer. Although learning to use branching skills or scanning skills could broaden his use of both computers and augmentative communication systems, he adamantly refuses to cooperate with learning the necessary prerequisites, such as waiting for the correct time to press the switch. Therefore, because there seem to be no other access options for him at this time, he continues to be limited to single-switch activities on the computer.

Computer use is extremely motivating to Travis, but only on his terms of self-determining the course of that activity. Unfortunately, Travis has limited ability to control the computer effectively, and, when given complete control of the computer, does not gain optimal benefit from its use. At those times, he presses the switch or the mouse button randomly or attempts for long periods to maneuver the mouse. Often, he just watches other people and events in the classroom. When left with an assistant whose only duty is to help him do whatever he wants, Travis repeatedly asks to change programs, showing little interest in pursuing programs past the initial loading.

Observations of instructional activities at the computer show a number of compounding factors. Poor performance, as indicated by limited time on task, attention to task, and effort, is most in evidence when Travis is presented with tasks that are either too hard or too easy. Poorly defined goals, such as "work well for 10 minutes", lack of corrective feedback, inconsistent reinforcement, inconsistent expectations, and a general lack of training or information regarding planning and presentation of a lesson were often in evidence, particularly when the supervising adult was a non-certified staff member. The most nonproductive "learning" sessions occurred when he was left alone with boring, unchallenging, repetitive software. Travis was quite adept at pressing the mouse or switch just enough to set off the auditory sounds that staff members used to judge whether he was "working" or not. During sessions of this type, which occurred regularly in the summer sessions, he displayed no misbehaviors, and seemed to enjoy the activity. However, analysis of the tapes shows him to be off-task around 98% of the time, looking at everything going on in the room, and at times, even nodding off, only to be awakened when his head hit the tray or table.

Displays of oppositional behaviors were most intense when Travis was required to perform tasks he did not like at the computer, tasks for which he could develop no accommodative behavioral strategy (as with the switch training activity mentioned above). He particularly disliked a typing activity, and would react with intense misbehaviors each time it was assigned. After repeatedly signing "finished", his behaviors would continue to escalate until he was removed from the task.

At other times, Travis' performance at structured computer-based tasks was pleasant and productive. When teachers used direct instruction, appropriate assignments, recognition of communicative efforts, and various strategies designed to engage internal motivation (such as challenge, curiosity, control, etc.), there were noticeable increases in Travis' attention to task, engagement, and performance.

While most certified teachers seem to be aware of the need for proper implementation of the technology-based activities, classified staff interactions with Travis and his technology reflect a lack of training and a lower expectation level on the whole. The instructional time spent in summer sessions, where Travis' daily assigned tasks were largely left to the devices of noncertified staff, was basically wasted. For the most part, this series of paraprofessionals and teacher assistants (some of whom had worked with him, and many who had not), seemed to have no idea what he was doing or why. During these sessions, he was repeatedly assigned materials that were either too high or too low for his skill levels. He was inconsistently and inappropriately reinforced by workers who did not seem to have any notion of what the appropriate learning goal might be. The outcome of these sessions was nonproductive at best, and often difficult for all involved. Travis either met minimal requirements by "clicking" randomly, with no real engagement, or he fought the assignment with a determination that could not be swayed, as with the typing assignments.

Implications for practice. Use of computer is highly motivating for Travis. However, the use of that medium for specific purposes such as training of operational skills, learning curriculum, or even recreation and leisure, must involve more planning and structure to enable a productive use of time and equipment. Because Travis demonstrates high levels of intrinsic motivation for computer-based activities, and demonstrates that his engagement can be increased by use of strategies designed to enhance intrinsic motivation, the computer is one medium that holds potential to enhance learning opportunities. Additionally, because this medium can be intrinsically motivating and therefore produce his best effort, the computer environment is an ideal setting to explore and thus define his optimal ability levels. Further recommendations for computer-based learning activities are listed below.

- Computer-assisted learning activities should be planned, structured, and delivered by a knowledgeable educator.
- Direct instruction, with explanation of events, directions, accurate feedback, and appropriate reinforcement should be provided to produce optimum learning.
- More attention should be given to the difficulty level of the task and its developmental appropriateness. Is it too hard or too easy? Is the assigned task physically tiring?
- Proper attention should be given to design features of the software. Does it go on endlessly, or are there small goals embedded in the design? Are inaccurate responses rewarded? Is the content relevant, challenging, does it stimulate curiosity? Does it adjust itself to reflect the student's performance level? Does it give performance feedback?
- The goal of the activity should be clearly understood by the involved staff member, and clearly conveyed to Travis. In the switch-based computer activities, for example, was the goal to "keep clicking", or was it "click at the right time to hit the correct answer "?
- Criteria for completion of the activity should be understood by the supervising staff member and clearly defined for Travis. A concrete goal, such as complete five questions, is more intrinsically motivating than an abstract goal, such as "work for 10 minutes".
- Monitoring of needs and help as necessary should be available to any student who, like Travis, is limited in his ability to self-correct mistakes or operate the computer

independently.

- Judicious and consistent use of extrinsic reinforcers, with agreement among staff as to the appropriate use of reinforcers is needed. Should tangible reinforcers be used for tolerance of the activity, good behavior, or accurate responses within the activity?
- When working with students who have limited control over their actions and environment, increased consideration of techniques to enhance intrinsic motivation must occur. These techniques, which significantly affected Travis' performance, might include the use of challenge, curiosity, relevance, goal-setting, or enhanced opportunities for control and choice-making.
- Increased training, information, supervision, and feedback should be provided for noncertified staff members who are asked to implement communication training goals or computer-based activities.

Motivation, Self-esteem, Control, and Behavior

Although all of Travis' caregivers and educators felt that his self-esteem was positively affected by the use of technology, there was no imperical evidence to support those perceptions. However, Travis' attempts to control his own environment, his strong will and pronounced opposition to those who attempt to impose their will upon him, and his perseverance when practicing skills that he perceives to be relevant, all bespeak a healthy, intact sense of self-esteem.

Travis is strongly motivated by a desire for enhanced control of his environment and by working for increased independence. However, he experiences a great deal of frustration related to the inability to self-direct his own behavior. This becomes especially apparent in situations where task requirements are imposed, with staff making strong attempts to direct and control his behavior. The inability to control his daily life by complaining, explaining, negotiating, or physically escaping an aversive situation compounds his frustrations, and he communicates this with angry, disruptive, and sometimes dangerous behaviors. Those behaviors, when carried out to excess, powerfully communicate his distress, and, without fail, gain his goal of task avoidance. In this way, he successfully exerts self-determination and control over himself and his situation. At this time, the assistive technologies supplied to him have had little impact on providing the kind of control needed to relieve these frustrations and/or reduce the maladaptive behaviors.

Travis has demonstrated that he will use maladaptive behaviors to exert control over his life, especially when he strongly objects to circumstances he dislikes. One would not want to extinguish this strong drive within him. The challenge becomes, then, one of finding ways to increase his motivation for learning the educational tasks set before him, including technology-based tasks. The solutions likely lie as much in the teaching strategies and structure of the classroom as with the provision or configuration of the technology itself. Travis does respond to various strategies designed to increase intrinsic motivation, such as the stimulation of challenge, curiosity, or pride. He loves to show off his abilities. He also shows us that he will pursue activities longer, will persevere and try harder (all indicators of enhanced motivation) when he is convinced of the relevance of those activities, such as his unbelievable determination in learning to use his walker.

Travis' learning needs are unique and extreme. He needs software activities that are within his realm of ability, that are designed to create a no-lose learning situation, that are well-defined and set up to ignore mistaken activations and respond only to correct entries. He needs concrete goals in his assigned activities, and evaluative feedback based on accurate performance. Reinforcers, such as "free time", music center, printing, and verbal praise all need to be contingent on <u>accurate</u> performance, not just performance. He needs to be given as much independence and autonomy as possible, with time to try things on his own, at his own pace. He needs a consistent approach to the misbehaviors, approaches and responses that do not accidentally reinforce the maladaptive behaviors. He needs adults to pay more attention to providing communication opportunities for him at every possible time. And he needs more choices, and the perception of more control. Staff members are in desperate need of training in these areas.

<u>Implications for practice.</u> For Travis, intrinsic motivation is the most powerful factor involved in increasing performance and learning. Special attention must be given to his level of intrinsic motivation for any particular task.

- Tasks to which Travis objects should be examined for relevance, challenge, curiosity, and control features.
- Tasks should be modified to promote intrinsic motivation.
- Enhanced perception of control, via choices, increased opportunity for communication, and verbal instruction (as opposed to physical manipulation), should be provided in greater degree.
- Staff training in the implementation of strategies to increase intrinsic motivation is needed.

Social Interactions and Inclusion

Even though this investigation found the use of technology was minimal in the inclusive setting and in peer interactions, key informants in the study felt that Travis' peers were beginning to find new ways to interact with him, to ask him questions, and understand his answers, and that technology was a factor promoting these changes. Through use of the technology, Travis was able to share important events with his peers, and perhaps this helped them see him as a real person with thoughts, feelings, and needs similar to their own. Adults in the study also felt that technology provided an avenue for Travis to play with peers—a "virtual" playground that could level the playing field for him. Indeed, the powerful computer world creates an opportunity for Travis to alleviate physical limitations, such as the inability to walk, run, or shout, and provides it in a format that is familiar and pleasing to almost all children of his age. There was some evidence that this phenomenon was encouraged and seen more frequently in earlier grades.

There were a few occasions observed when technology was used to assist in peer-based activities. However, on a daily basis, technology was not observed to affect the quality of inclusion and social interactions with peers. Unfortunately, the daily fourth grade class that Travis attended was one where no talking was permitted, and therefore it afforded almost no opportunity for social interaction. Under these circumstances, it seems unlikely that anything, including technology, would have increased the quality of his interaction with peers in the general education classroom. However, on those rare occasions when Travis was included in parties, plays, or speeches, his ability to communicate information with his classmates by giving a speech about himself via a looptaped message provided a bright spot in this study.

Implications for practice. In Travis' case, it seemed that factors other than technology affected social interactions and inclusion activities to a greater degree than the use or non-use of technology-based tools. Therefore, implications for practice include the following recommendations, which are summarized below.

- When inclusion opportunities are being chosen, consideration must be given to the general type of activities, and the likelihood of social interaction.
- Communication opportunities and social activities are a necessary part of inclusion.
- Information and training is needed for regular education teachers and peers to create ongoing opportunities for social interaction and communication.

Expectations and Attitudes of Others

Technology is having a noticeable effect on the expectations, goals, hopes, and dreams of those involved with Travis H. In this study, the strongest effect on adult expectations and behaviors occurs when Travis uses technology to demonstrate his ability to learn, or to demonstrate a skill or ability that was previously impossible. This powerful phenomenon helps people begin to understand that having a disability does not necessarily mean that the student is incapable of learning or performing. When people see that Travis CAN do a certain thing, their expectations change. Consider, for example, a skill like counting objects. Travis may have been able to count before he had assistive technology, but he was not able to demonstrate the ability by giving correct answers, either verbally or on paper. Before they saw him demonstrate the skill, their attribution was likely to be "he can't do that, poor thing, he's just not able", and they therefore would not expect him, or even ask him to do it. When teachers become aware that he has performed the task in the past, though, it changes their thinking in reference to a requested performance of the task. The attribution they will assign his behavior, then, is one that assumes he is in control of the situation, that he can do it if he wants to. The adults around him, as well as the children, have higher or lower expectations, depending on whether or not he has demonstrated a particular ability.

Implications for practice. Although there is little measurable indications, technololgy is beginning to show effects on the expectations and attitudes of people around Travis in the school setting. Recommendations for expanding that impact are summarized below.

- When technology helps Travis demonstrate a new ability, one he was previously unable to perform, it directly affects the attributions that people assign to his behaviors, and the resulting expectations that people have for him.
- When Travis' abilities are positively affected by the implementation of technology, the demonstration of those abilities should be more publicly shared. Because Travis has demonstrated pride in his abilities, it is appropriate to actively facilitate further demonstration of those abilities. All opportunities for demonstration should be pursued whenever possible. Hard copies of his work should be collected and shared with parents, classmates, etc. Activities such as a show-and-tell activity, a speech to the class, a school play, or a poster competition, could be used to demonstrate Travis' abilities to larger numbers of peers and adults in the educational setting.

The Impact of Assistive Technology Use on the Educational System

Travis' school is unique and quite progressive in its provision of an unusually large amount of technology devices, materials, equipment, and support for the use of assistive technology. The large amount of computer-generated materials, adaptives, and specialized software testify to an effort made by this school system to support and promote Travis' use of these tools to alleviate the limitations imposed by his disabilities. While other schools struggle to get one augmentative communication device, or one piece of adaptive equipment for computer access, Travis has been provided with trials of many different devices, materials, and correlating adaptive and assistive strategies.

However, provision of the devices and materials themselves is only the tip of the proverbial iceberg. There are huge needs that come hand-in-hand with these tools. The implementation of assistive technology tools imposes a whole list of new responsibilities for educators in the classroom. The amount of time needed for training the staff to <u>use</u> the devices or <u>make</u> the materials is very significant, and adds to an already significant increase in the amount of non-instructional demands. Now they have to remember to keep the device charged, in front of the child, and properly programmed. They have to increase their own computer skills, and learn how to use special adaptations like switch-interfaces or switch-training software. There are new materials, such as icon- or overlay-authoring software programs that must be learned, implemented and practiced. They may have to attend additional communication meetings to discuss the phrases that are needed in various activities. They have to think about what phrases he has on the device, and remember to use strategies to increase his use of the device.

Educators must learn new strategies for training the child to operate the computer or device. In addition, there is an increased need to improve strategies necessary for teaching in new content areas. When technology is implemented, teachers and other staff members are suddenly involved in training the student to communicate, or to learn to spell, or to learn to travel to the bathroom independently (now that he can ask to go to the bathroom). Instead of teaching the child how to wash his hands or tie his shoes, they find themselves involved in teaching the child how to count, develop money skills, recognize letters or consonant sounds, develop language structures, or communicate effectively.

As we approach the 21st century, many teachers still have not received training in their teacher training programs on how to teach at the computer. They may not have been introduced to the concept of augmentative or alternative communication before having a nonverbal student in their classroom. These teachers are out there in classrooms, struggling with new mandates for the use of assistive technology with students with severe disabilities, and they have neither time nor resources to begin the process of developing the skills they need to see successful use of these technologies.

Teaching at the computer, training a child to use augmentative communication overlay, or using the tools to teach independent functioning skills are new pedagogical requirements that have been mandated without much training or support for teachers in the business of educating students with severe or multiple disabilities. For the most part, there has been very little additional time allotted for learning about these activities. The Special

Educator, whose time constraints have increased astronomically over the past decade due to paperwork, documentation, and other training concerns, is expected to somehow magically add these skills to their repertoire of teaching strategies. And the paraprofessional, who may have very little training in even the basics of child care, is left with more and more responsibility for direct care of the students while teacher struggles with additional time for training themselves in this area.

Of all of the needs, however, that are generated by introducing new technologies to students with significant disabilities, perhaps the most difficult challenge is the resulting disequilibrium in underlying philosophical structures and beliefs. A huge and pervasive conflict in the educational system is created by the axiomatic changes that occur when formerly dependent students (like Travis) are given tools that can expand the scope of their ability levels. Because of these changing boundaries, the field of teaching individuals with serious disabilities is undergoing a period of dramatic, system-wide change.

Staff are caught in the middle of a complete change in long-held philosophies of treatment for individuals with this serious type of disabilities. "Let them talk or not?" "let them click or not?" -- these are issues that are addressed in dramatically different ways for nondisabled kids. In some way, the sweet temptation of learned dependence is a two-way street. And it requires that both the child and the adult learn new ways of dealing with issues that were not relevant before technology created the possibility of greater independence.

Educators cannot tape the mouths of students with normal communication--they must deal with modifying inappropriate verbalizations or annoying questions in ways designed to teach the child a larger set of rules. They must teach the child that there are times and ways to say things, and there are consequences to what one says. That child is taught to modify his own behavior, but he still has the choice of whether or not to disobey the teacher. Unfortunately, a student who is nonverbal, who now has some power to "say" something (via augmentative communication) can be quickly and easily dealt with by removal of the device. The educator who fails to place an available device within the student's reach is, in essence, restricting that student's ability to communicate.

A student who can willfully move the mouse, in direct opposition to teacher's directive, is dealt with in a far different fashion than the one who can't reach the mouse (or switch) when it's moved to the side. Teachers who would never consider taping a child's mouth or gluing a student's hands to the table will quickly remove a device, or move a switch away from his reach, without realizing how they are using the child's disability against him. Children who can now say, via alternative communication, "I need to go to the bathroom" are still being taken to the bathroom on a scheduled basis, ignoring the misbehaviors that say "I don't need/want to go now". A child with the ability to say "I need to go to the bathroom" would never be taken when they didn't want to go. The expectation would be that he is able to tell a staff member when necessary.

Many of the staff in this study reflect stereotyped beliefs in their dealings with Travis, beliefs that translate into interactions that seem to promote learned helplessness and reduce independent behaviors. Now that Travis suddenly has the capability of, for example, asking to go to the bathroom as necessary, the whole axiom upon which they base their profession has changed. He is no longer dependent on them to project his needs and provide for him. Staff continue to struggle, each in their own way, with these shifting issues of autonomy and learned helplessness.

One might speculate that Travis' educational treatment issues are being, or will be, replicated in a thousand different settings in the next decade in American public schools. Teachers have very little, if any, training and information to help them deal with the issues that are brought to the forefront by assistive technology.

<u>Implications for the Field</u>

Because of current legislative mandates, assistive technology is appearing in school settings with increasing frequency. However, these tools may be poorly implemented due to lack of information and training for educators in the field of special education, particularly for those working with students with severe disabilities. A number of implications and recommendations to improve the use of assistive technology tools are listed below.

- Technology alone, without extensive training and support, is not productive in impacting functional or curricular goals for students with severe or multiple disabilities.
- To properly implement the use of tools designed to promote independence, teachers and other staff members need training and information regarding self-determination, control and autonomy, promoting independence, use of intrinsic motivation, and corrective feedback.
- To properly implement the use of tools designed to facilitate alternative communication for students with severe communication disorders, teachers and other staff

members need training and information regarding communication training methods; i.e., training the student to communicate effectively regardless of the devices or tools used for alternative communication.

- A trans-disciplinary approach is needed to provide opportunities for inclusion that promote social interactions, communication with peers, and independent functioning. Time for collaboration is a necessary component of successful inclusion opportunities.
- Paraprofessionals and other support staff need basic training regarding the needs of students with severe/multiple disabilities in all areas--teaching strategies, motivation, behavioral interventions, and communication training. We cannot expect our paraeducators or teaching assistants, who are often given the responsibility for teaching those students, to support assistive technology, when they are left in the dark regarding the rationale for those devices and strategies.
- Extended School Year programs need more trained staff in order to provide effective use of technology in the summer sessions.
- Teachers or staff working with students with severe disabilities at computer-assisted learning tasks must consider the following:
  - the relevance and developmental appropriateness of the lesson content
  - the relevance of the goals, to both the student and the educational staff-- effective techniques for enhancing intrinsic motivation
  - difficulty of the task--both cognitive and physical
  - task requirements
  - criteria for completion

- Educators are in desperate need of time for training in the implementation of goals which are supported by the use of technology.

<u>Limitations of the Study</u>

This study is limited to information which can be gained solely from the case presented. The study was limited to only one purposefully chosen student, his family members, and the staff working with him, rather than a random selection from all students with severe/multiple disabilities on all public school campuses in the country. Therefore, external validity cannot be firmly established and the results cannot be predicted to occur or be proven applicable to other students in similar situations. Internal validity in this study is affected by an endless array of variables, including history, maturation, situational motivation, differing approaches of various personnel, issues of control and independence, and the inability of the subject to effectively communicate important variables such as illness, dislike of task, dislike of personnel, discomfort, etc. Because of these factors, the research design chosen was an observational, exploratory case study. Therefore, no precise correlation or causation can be made.

Investigator bias in perceptions and subjectivity, due to previous history with the subject and setting, is a major threat to the reliability of this study. Although strict procedures for documentation were observed, one should not assume that the same conclusions would be drawn by another investigator. The perceptions of this researcher over two decades of work with children with special needs have likely influenced both the focus of inquiry, and the associated findings. And so, I leave each reader with their own interpretations of the descriptions and conclusions presented here.

Implications for Further Research

Travis' case is unique in the fact that he has such a tremendous number of unknown variables operating at any given time. An extended project that includes motivational strategies, with a consistent response/reinforcement system in place, might help to reduce some of the compounding variables that are affecting Travis' behavior and performance in reaction to tasks he does not particularly appreciate.

An extension of this project to further investigate staff understanding and attitudes concerning the use of augmentative communication tools would be an interesting and timely topic. Given widespread lack of training in the field, information concerning educator's axiomatic beliefs (and how those beliefs are expressed) could provide teacher training programs with information necessary to develop professional training tools in this very new, ground-breaking area of assistive technology use in the education of students with disabilities.

The use of computers and technology to instruct children with severe or multiple disabilities is a phenomenon that is so recent that there is very little information available to guide teachers in their attempts along these lines. As computer access becomes more user-friendly for students with limited motor abilities, we will predictably begin to see a change in the limits of their ability. Information and research to help educators and students take full advantage of these new tools is desperately needed.

Research is also needed to begin investigation into the motivational constructs and needs of students with severe or multiple disabilities who are using technology. Are there similarities in motivational strategies for students with severe disabilities? What are the differences or unique needs of this student population, as related to technology use? How does motivation interact with the struggle to create optimal conditions for observational assessment of each child's abilities? How are motivation and self-determination related to technolgoy? -- how does this concept differ when students have communication impairment, and how does it interact with the educational need to train or teach students operational skills for technology use? These areas of study are so virginal, so lacking in precedent, in scholarly information, and in provision of functional training for teachers and other professionals that the opportunity and need for research is open-ended.

Because this new medium provides opportunities for learning that did not exist previously, little is actually known about possible outcomes. The boundaries are quite unknown at this point. Many different areas of investigation must be initiated to further explore the expanding potential of this new development. To do this, we will need to consider not only how implementation of assistive technology affects the student in question, but how that implementation affects traditional teaching roles and the additional needs that are generated by the effort.

Final Thoughts on the Study

Travis attends a school system made up of individuals who are highly regarded, talented, caring, and well-intentioned. Each and every educator in this study appeared to be doing the best job they possibly could, given the limitations and constraints of the system itself. I found the teachers to be hard-working, concerned, and incredibly generous of their time and talents. The paraeducators were underpaid, overworked, and required to assume far more responsibility than one would find in any other near-minimum-wage job in today's market. The problems that are highlighted by this study are inherent in the field of special education, and in no way reflect a lack of desire by anyone to provide the best education possible for Travis.

The people that surround Travis are unbelievably caring and dedicated. Travis' school provides greater than average supports (supplemental staff, materials, etc.), more technology than usual, and a philosophy of inclusion. Still, the problems are vast, and the work has just begun.

Travis working at the computer.

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APPENDIX A

Sample Interview Questions about Technology Effects (staff/teacher).

- Describe briefly and specifically the type(s) of technology the student is using at school?
- What equipment is he/she using?
- How long has the student been using this equipment?
- How and when is he/she using that technology?
- What is the purpose of that assistive technology use?
- Does the use of that technology affect the educational environment? How?
- Have you observed any impact on the student's academic performance? (elaborate)
- Have you observed any impact on the student's behavior?
- Have you observed any impact on the student's motivation level?
- Have you observed any impact on the student's social interactions with peers or adults?
- Have you observed any impact on the student's participation?
- Have you observed any impact on the student's self-esteem?
- Have you observed any impact on the inclusive classroom setting
- Have you observed any impact on the attitudes or expectations of peers?
- Have you observed any impact on the attitudes or expectations of adults?
- Have you observed any impact on your own attitudes or expectations for the student?
- Have you observed any impact on educational goals or curriculum expectations?
- How does computer use affect learning or teaching with this student?
- What strategies have you found effective or successful?
- What problems have you noticed in reference to use of technology with this or other students?

Sample Interview Questions about Technology Effects (parent).

- Describe briefly and specifically the type(s) of technology your child is using at school?
- What equipment is he/she using?
- How long has (your child) been using this equipment?
- How and when is he/she using that technology?
- What is the purpose of that assistive technology use?
- Do you use the technology at home?
- Does the use of that technology affect the home environment? How?
- Does the use of that technology affect the educational environment? How?
- Have you observed any impact on (your child's) academic performance? (elaborate)
- Have you observed any impact on (your child's) behavior?
- Have you observed any impact on (your child's) motivation level?
- Have you observed any impact on (your child's) social interactions with peers or adults?
- Have you observed any impact on (your child's) participation?
- Have you observed any impact on (your child's) self-esteem?
- Have you observed any impact on inclusion into the regular ed classroom setting?
- Have you observed any impact on the attitudes or expectations of peers?
- Have you observed any impact on the attitudes or expectations of adults?
- Have you observed any impact on your own attitudes or expectations for (your child)?
- Have you observed any impact on educational goals or curriculum expectations?
- How does computer use affect learning or teaching with this student?
- What strategies do you think have been effective or successful?
- What problems have you noticed in reference to use of technology?

NOTE: Non-directive probing will be used in initial interviews, which will begin with the following "foreshadowed questions", framed in an open-ended format.

APPENDIX B - DATA LOG
Records and Documents

Doc 1	IEP - end of 4th grade	4/8/98
Doc 2	IEP - end of 3th grade	4/8/97
Doc 3	IEP - end of 2nd grade	4/9/96
Doc 4	IEP - end of 1st grade	4/21/95
Doc 5	IEP - end of Developmental 1st grade	4/21/94
Doc 6	MEPTS - 3 year re-evaluation plan and summary	4/8/97
Doc 7	MEPTS - 3 year re-evaluation plan and summary	4/21/94
Doc 8	Psychoeducational Test Results	4/5/97
Doc 9	Psychoeducational Test Results	4/4/94
Doc 10	IEP at a glance - 4th grade	8/30/94
Doc 11	ESY school-home daily reports	
Doc 12	Assistive Technology evaluation	5/18/98
Doc 13	Positioning and motor control evaluation	5/19/98
Doc 14	Physical Therapy-letter to Mother, summary and recommendations	
Doc 15	Occupational Therapy program summary	
Doc 16	Augmentative/alternative communication assessment	5/19/98
Doc 17	Icons used by Travis for communication	
Doc 18	Inservice materials used to train staff and peers	
Doc 19	work sample, 2nd grade	10/3/95

APPENDIX C - DATA LOG
VIDEOTAPED OBSERVATIONS

Number	Date	Length (in minutes)	Location
VO 01	10/9/95	30	EE-2nd gr SpEd lab
VO 02	6/11/97	5	ESY
VO 03	6/16/97	13	ESY
VO 04	6/17/97	12	ESY
VO 05	6/19/97	30	ESY
VO 06	6/23/97	17	ESY
VO 07	6/24/97	24	ESY
VO 08	6/25/97	21	ESY
VO 09	7/3/97	8	ESY
VO 10	7/9/97	21.33	ESY
VO 11	7/14/97	30.5	ESY
VO 12	7/15/97	18.33	ESY
VO 13	7/17/97	36.5	ESY
VO 14	7/21/97	27.83	ESY
VO 15	7/22/97	27.17	ESY
VO 16	9/16/97	16	EE- halls, office
VO 17	9/22/97	8.92	EE-classroom, outside
VO 18	9/26/97	24.08	EE-halls, outside, clinic
VO 19	10/2/97	6.33	EE-SpEd lab
VO 20	10/7/97	2.17	EE-SpEd lab
VO 21	10/9/97	0	EE-4th grade classroom
VO 22	10/13/97	12	EE-SpEd lab
VO 23	10/21/97	8.5	EE-4th grade classrooms
VO 24	10/28/97	13.33	EE-SpEd lab
VO 25	11/4/97	7.5	EE-Speech lab
VO 26	11/7/97	6.5	EE-all over, inside and out
VO 27	11/12/97	11.67	EE-4th grade classroom
VO 28	11/13/97	9.5	EE-SpEd lab
VO 29	11/18/97	7.5	EE-SpEd lab
VO 30	11/21/97	4.42	EE-SpEd lab
VO 31	11/25/97	7.33	EE-Speech Lab
VO 32	12/2/97	9.92	EE-SpEd lab, clinic, halls
VO 33	12/4/97	2.25	EE-SpEd lab
VO 34	12/8/97	3.42	EE-SpEd lab
VO 35	12/11/97	20.67	EE-SpEd lab
VO 36	12/15/97	21	EE-Speech Lab

note: ESY = Extended School Year setting
EE = Eastside Elementary School

APPENDIX D - DATA LOG
INTERVIEWS

INT #	CODE	DATE	POSITION
#1	T3	7/10/97	SpEd teacher - grade 3
#2	PP	7/2/97	Paraprofessional
#3	OIS	7/8/97	Orthopedic Impairment Specialist
#4	MO	7/17/97	Mother
#6	T4	7/9/98	SpEd teacher - grade 4
#5	PT	2/18/98	Physical Therapist

APPENDIX E

CASE STUDY DATA BASE
List of data sources

The **CASE STUDY DATA BASE** is a list of materials contained in two metal file carriers, which are available for purposes of verification and scholarly review. The carriers contain the following materials:

1. <u>MASTER VIDEOTAPES</u>, each of which contain a copy of several of the 36 individual videotaped observations.

MASTER TAPE 1

VO 01	10/9/95

MASTER TAPE 2

VO 02	6/11/97
VO 03	6/16/97
VO 04	6/17/97
VO 05	6/19/97
VO 06	6/23/97

MASTER TAPE 3

VO 07	6/24/97
VO 08	6/25/97

MASTER TAPE 4

VO 09	7/3/97
VO 10	7/9/97
VO 11	7/14/97

MASTER TAPE 5

VO 12	7/15/97
VO 13	7/17/97

MASTER TAPE 6

VO 14	7/21/97
VO 15	7/22/97

MASTER TAPE 7

VO 16	9/16/97
VO 17	9/22/97
VO 18	9/26/97
VO 19	10/2/97
VO 20	10/7/97
VO 21	10/9/97
VO 22	10/13/97

MASTER TAPE 8

VO 23	10/21/97
VO 24	10/28/97

MASTER TAPE 9

VO 25	11/4/97
VO 26	11/7/97
VO 27	11/12/97
VO 28	11/13/97
VO 29	11/18/97
VO 30	11/21/97
VO 31	11/25/97

MASTER TAPE 10

VO 32	12/2/97
VO 33	12/4/97
VO 34	12/8/97
VO 35	12/11/97
VO 36	12/15/97

Appendix E (continued)

2. AUDIOTAPED INTERVIEWS

INT #	CODE	DATE	POSITION
#1	T3	7/10/97	SpEd teacher - grade 3
#2	PP	7/2/97	Paraprofessional
#3	OIS	7/8/97	Orthopedic Impairment Specialist
#4	MO	7/17/97	Mother
#6	T4	7/9/98	SpEd teacher - grade 4
#5	PT	2/18/98	Physical Therapist

3. DOCUMENTS, including a transcript of each interview, a transcripted set of video observation notes (for each of 36 videotaped observations)

Doc 1 IEP - end of 4th grade 4/8/98
Doc 2 IEP - end of 3th grade 4/8/97
Doc 3 IEP - end of 2nd grade 4/9/96
Doc 4 IEP - end of 1st grade 4/21/95
Doc 5 IEP - end of Developmental 1st grade 4/21/94
Doc 6 MEPTS - 3 year re-evaluation plan and summary 4/8/97
Doc 7 MEPTS - 3 year re-evaluation plan and summary 4/21/94
Doc 8 Psychoeducational Test Results 4/5/97
Doc 9 Psychoeducational Test Results 4/4/94
Doc 10 IEP at a glance - 4th grade 8/30/94
Doc 11 ESY school-home daily reports
Doc 12 Assistive Technology evaluation 5/18/98
Doc 13 Positioning and motor control evaluation 5/19/98
Doc 14 Physical Therapy-letter to Mother, summary and recommendations
Doc 15 Occupational Therapy program summary
Doc 16 Augmentative/alternative communication assessment 5/19/98
Doc 17 Icons used by Travis for communication
Doc 18 Inservice materials used to train staff and peers
Doc 19 work sample, 2nd grade 10/3/95
Doc 20 Field notes

4. RELATED DOCUMENTS

PROSPECTUS MEETING MAY 1997 - Notes and suggestions from committee members
DISSERTATION READING COPY - June 1999
INTERVIEW TRANSCRIPTS
VIDEOTAPED OBSERVATION TRANSCRIPTS
DATA ANALYSIS NOTES
OBSERVATIONS - FIELD NOTES
DOCUMENTS - NOT USED
MISCELLANEOUS INFORMATION

APPENDIX F-- PRODUCT INFORMATION

Apple IIE and Apple GS - two of the first computers commonly found in school systems during the 1980s. Most had 48K -128K of RAM. Apple Computer, Cupertino, CA.

Biggy - a software utility program that provides a selection of enlarged cursor choices. R.J.Cooper & Associates, Dana Point, CA.

Boardmaker - an authoring program that provides easy authoring and production of picture icons based on icons from the Picture Communication Symbols set. Mayer-Johnson, Solana Beach, CA.

Cheaptalk--an inexpensive device that holds 4 or 8 phrases, each of which is easily programmed via voice recording. Buttons are easily activated, or may be switch activated (no scanning access). Toys for Special Children/Enabling Devices, Hasting-on-Hudson, NY.

Echo II -synthesized speech system for the Apple series of computers that provided sound and voice, it included an internal memory card, an external speaker, and software. Echo Speech Corporation.

Hit 'n Time - software made specifically to train persons in accurate switch-activated scanning skills. Each of three simple games requires an element of accurate timing. Jokus Software.

Intellikeys - an expanded keyboard that can be programmed to display different keyboard configurations. Connects directly to MacIntosh or IBM/PC computers, requiring no interface hardware. Intellitools, Novato, CA.

Intellipics - early education software with built-in options for alternative access. Intellitools, Novato, CA.

Introtalker - a sophisticated augmentative communication device that can hold up to 32 phrases or more (with linking). It is portable, uses overlays, and has expandable memory capacity. Voice recording is required. An older device, it has been upgraded/replaced with the AlphaTalker. Prentke-Romiche Company, Wooster, OH.

Jellybean switch - a small, round, commonly used switch that comes in many colors. AbleNet, Inc., Minneapolis, MN.

Light Talker - a sophisticated augmentative device that provides an expanded reportoire for communication. Prentke-Romiche Company, Wooster, OH.

Macaw - a sophisticated augmentative communication device that can hold several different levels of phrases and can provide scanning features. It is portable, uses overlays, and has expandable memory capacity. Voice recording is required. Zygo, Inc., Portland, OR.

MacIntosh III - a popular desktop computer for school systems in the 90s, it evolved somewhere between the GS line and the PowerMac. It provides 4-36 MB of RAM and a Windows desktop environment. Apple Computers, Cupertino, CA.

Appendix F (continued)

Millie's Math House - Early childhood educational/entertainment software, it gives instruction and practice in concept areas of numbers, counting, shapes, and relational concepts. Davidson, Inc.

One-Step Communicators - raised, angled switches that are voice-augmented via a simple loop-tape setup. They are simple to record, but only hold one phrase or short message. AbleNet, Inc., Minneapolis MN.

Powerlink - an environmental control unit which provides a switch interface for all electrical appliances. AbleNet, Inc., Minneapolis MN.

See, Hear, and Say - language training software that contains Boardmaker icons with auditory labels grouped by beginning consonant sound. Mayer-Johnson, Solana Beach, CA.

Speakeasy - a medium-cost augmentative communication device that is portable and durable. It holds up to 12 phrases, each of which can be accessed via switches (no scanning features). Voice recording is required. AbleNet, Inc., Minneapolis MN.

Switch Intro - software made specifically to train persons in accurate switch use, including cause-and-effect activities and simple training activities for learning to scan. Jokus Software.

TouchTalker - a sophisticated augmentative device that provides an expanded reportoire for communication. Prentke-Romiche Company, Wooster, OH.

Unicorn - an expanded keyboard that can be programmed to display different keyboard configurations. One of the first commonly used expanded keyboards, it requires the Adaptive Firmware Card (or Ke:Nx/Discover) as an interface. Don Johnston, Inc., Wauconda, IL.

Write Outloud - a simplified text-to-speech software that allows the computer to read words, sentences, or complete documents aloud. Don Johnston, Inc., Wauconda, IL.

APPENDIX G

AUDIT TRAIL/CHAIN OF EVIDENCE

ACHIEVEMENT - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Technology was used in Travis' educational environment repeatedly to provide materials and tools for learning. The school system provided a large amount of software, a variety of adaptive devices, and use of technology-generated materials for his instructional use.
EVIDENCE: Interviews - T3, 1-7; OIS, 1-3; MO, 3; T4, 6-9; PP, 1-7; Figures 1, 2, 3, 4, 5, 6; Table 1; Documents 12, 16, 17.

2) Despite the large amount of technology supports, there was little evidence of successful learning on targeted academic skills. Although computers were used for assigned learning tasks, including basic matching and beginning literacy, Travis was often either uncooperative or unengaged with the assigned task.
EVIDENCE: Videotaped observations in which Travis was either uncooperative or unengaged with the assigned task: Observations - VO 1, 3, 4, 5, 10, 11, 13, 14, 15, 22, 24, 30, 35.

3A) Computer-based learning sessions often reflected little use of applied theories of teaching and learning. Travis' assignments were often either too easy, as with the repetitive, boring cause/effect programs, or too difficult as with the typing tasks.
EVIDENCE: Observations - VO 1, 3, 5, 6, 8; Figure 9; Document 11.

3B) Activities that reflected more attention to relevancy of materials, clearer goals, monitoring and feedback, and use of motivational techniques, resulted in an increase in on-task behavior and cooperation and a reduction in oppositional behaviors.
EVIDENCE: Observations - VO 7, 25, 31, 34, 36.

4) Learning and performance outcomes appeared to be directly affected by the application (or lack of application) of teaching strategies and learning theories that surrounded the use of technology. The technology itself, when used in the absence of sound teaching strategies, appeared to have no impact on learning. When technology was used with a combination of proven strategies, Travis' cooperation and time on-task increased.
EVIDENCE: This conclusion is based on comparison and synthesis of all observed computer-based learning activities and other demonstrations of technology use. The conclusion is drawn from #3 and #4 above.

COMMUNICATION SKILLS - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Travis preferred simple low-tech or no-tech devices and materials to more sophisticated augmentative communication systems. As a result, the actual amount of communication phrases available to Travis was very small.
EVIDENCE: Document 12, p. 1, p. 4; Document 16, pp. 2-3; Table 1; Interview - OIS, p. 1; pervasive in context of videotaped observations.

2) Although there was an obvious effort to provide materials and devices, Travis had limited physical access to those tools, resulting in restricted opportunities for spontaneous or appropriate communication.

Appendix G (continued)

EVIDENCE: Supporting data for a review of all videotaped observations (see Appendix H) shows devices and materials consistently in the environment, however, the materials were inaccessible to Travis. Picture icons were out of his reach approximately 75% of the total taping time, and augmentative devices were out of his reach approximately 90% of the total taping time (see Figure 8).

3) When materials were accessible, communication skills were positively impacted by the use of a computer-generated icon system and various supplemental low-tech devices. Travis was able to use those materials to communicate need and preferences, thus providing more control and choice in his daily activities.

EVIDENCE: Document 12, p. 1, p. 4; Document 16, pp. 2-3. Observation - VO 23, VO 24, VI 29; Interviews - Table 1 (staff descriptions of Travis' use of technology-based communication).

BEHAVIOR - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Travis repeatedly displayed significant maladaptive behaviors during many structured computer-based tasks, and those behaviors interfered with learning and performance.

EVIDENCE: Table 3 (Excerpts from daily correspondence with parents; Table 2 (Descriptions by participants of Travis' oppositional behaviors); Interview - OIS, p. 3; Observation - VO 1, VO 4; Document 12, pp. 2-3.

2) Communication opportunities were limited throughout the sessions, increasing the probability of maladaptive behaviors. Augmentative communication devices and low-tech picture icons were available, but rarely were within Travis' reach.

EVIDENCE: As seen in Figure 8, picture icons were out of his reach approximately 75% of the total taping time, and augmentative devices were out of his reach approximately 90% of the total taping time. Supporting data can be seen in Appendix H.

2B) Even when the tools were within Travis' reach, their use was very inconsistently reinforced by staff.

EVIDENCE: Observations - VO 4, p. 1; VO 6, p. 1; VO 8, p. 2; VO 24, p. 1.

3) On-task behaviors at the computer, along with cooperation and effort, were increased in sessions where curricular tasks were neither too low or too high. Those behaviors were increased during sessions that contained specific teaching techniques— direct instruction and monitoring of needs, appropriate feedback/reinforcement, challenge, curiosity, control/choice-making, and recognition of communication attempts. Oppositional behaviors were decreased at these times, most likely due to increased intrinsic motivation and/or increased communication opportunities.

EVIDENCE: A comparison was made of computer-based sessions in which Travis was either uncooperative or unengaged with the assigned task, i.e.; VOs 1, 3, 4, 5, 10, 11, 13, 14, 15, 22, 24, 30, 35 to videotaped observations of computer-assisted sessions in which Travis was significantly more engaged, cooperative, and ontask, i.e.; VO 7, 25, 31, 34, 36).

Appendix G (continued)

MOTIVATION - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Travis was strongly motivated by independent use of the computer. Although unassisted use of the computer was often unproductive in meeting educational goals, he continued to enjoy it immensely.

EVIDENCE: Interviews - PP, p. 3; T4, pp. 1-3; OIS, p. 4.

2) Technology increased Travis' ability to exert autonomous control of his environment, and his motivation was strongly related to his ability to control various tasks. Technology added an element of independence into both of his two most preferred activities, i.e., computer play and listening to music/books. He was able to operate the tape player/radio much more independently through use of the switch-activated unit, and he was able to interact with the computer in a more independent fashion when using special software and input adaptations.

EVIDENCE: Document 12, p. 4; Interviews - OIS, p. 6; T4, pp. 2-3; T3, pp. 3-4; PP, p. 7; Observations - VO 25, VO 34, VO 36.

3) In technology-based work sessions, Travis' internal motivation, as expressed by time on task, level of engagement, interest, and perseverance, was increased by strategies designed to provide a well-structured task, such as direct instruction and monitoring of needs. Strategies used to increase internal motivation, i.e., use of choice-making, challenge, relevance of the curriculum, goal-setting, increasing perceived control, and recognition of communication attempts were also met with noticeably better cooperation, perseveration, and attention to task.

EVIDENCE: A comparison of teaching strategies was made of computer-based sessions in which Travis was either uncooperative or unengaged with the assigned task, i.e.; Videotaped observations VO 1, 3, 4, 5, 10, 11, 13, 14, 15, 22, 24, 30, 35 to videotaped observations of computer-assisted sessions in which Travis was significantly more engaged, cooperative, and ontask - VO 7, 25, 31, 34, 36).

SELF-ESTEEM - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Technology-based materials and systems in the classroom had some effect on Travis' ability to make choices and determine his own actions. He used his picture icon system to give himself more situational control, such as a choice of which assignment to do next, or which type of snack he preferred.

EVIDENCE: Interviews - T4, p. 12; T3, p.1, pp. 3-4; PP, p. 2, p. 7; OIS, p. 1. Observations - VO 24, VO 36. Document 12, p. 1, p. 4.

2A) Travis was able to operate equipment more independently by use of computer adaptations and switch-activated environmental control equipment.

EVIDENCE: Interviews - T4, p. 9; T3, pp. 3-4; PP, p. 7; Mo, p. 3; Document 12, p. 2.

2B) He also used computer free-time to control the behavior of staff members, by constantly requesting they change programs for him. More autonomy in these areas seem to have enhanced Travis' feelings of competency.

EVIDENCE: Observations - VO 8, 10, 14; Interviews - T4, p. 8; OIS, p. 4; Document 12, p. 3.

Appendix G (continued)

2C) Theoretically, increased feelings of competency result in a more positive self-image. This was verified by those closest to Travis, who felt that technology had a positive effect on his self-esteem.

EVIDENCE: Table 4 contains excerpts from participants regarding their perceptions of technology's impact on Travis' self-esteem.

3) Issues of control, self-determination, and competency play a critical role in Travis' daily interactions in the educational setting. These issues take on new importance in congruence with Travis' newly developing abilities to effectively use technology to increase his own feelings of self-efficacy, competency, and control. Theoretically, increases in these areas should positively effect Travis' self-esteem.

EVIDENCE: This conclusion logically follows a synthesis of the above observations and conclusions regarding self-esteem, providing an analytic generalization.

SOCIAL/PEER INTERACTION - OBSERVATIONS/CONCLUSIONS VERIFIED

1) Technology had a limited effect on social interactions, except in the area of communication. There were increased opportunities for sharing information and responding to others via the communication system.

EVIDENCE: No observations showing effects in this area, other than communication, were noted. Social interactions were extremely limited in Travis' daily 4th grade class (Interview - T4, p. 10, p. 12; Field notes, 11-18-97), and other types of settings did not show any evidence of technology impact.

2) Adults felt that computer games were an important peer activity for Travis, however, observation did not support this perspective.

EVIDENCE: Interviews - MO, p. 5; PP, pp. 6-7; T3, p. 9; T4, p. 12. See #1 above--there were no observations or evidence of spontaneous computer play w/peers. In two instances, computer games were assigned by an adult, however, the students were not engaged or on-task (VO #3; VO #5).

3) In the special education classroom, Travis interacted far more with adults than with other children. These relationships revolved around assigned activities and educational/self help concerns.

EVIDENCE: Interview - T4, p. 3. Conclusion drawn by researcher after review of all videotapes and observation notes. There were very few occasions when Travis interacted for an extended time (more than a few seconds) with other children (VO 19 was the only example noted), and those occasions did not involve the use of technology.

4) There was little peer interaction in the inclusive setting, where opportunities for social interaction and communication were limited. No daily use of communication tools or other technology was observed.

EVIDENCE: Interview - T4, p. 10, p. 12; Field notes, 11-18-97.

Appendix G (continued)

EXPECTATIONS OF OTHERS - OBSERVATIONS/CONCLUSIONS VERIFIED

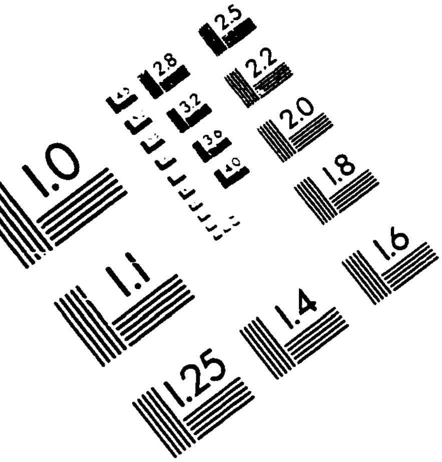
1) Assistive technology positively impacted the attitudes, beliefs, and expectations held by significant others in Travis' life--peers, adult professionals, and family members. There was a particularly powerful effect when Travis demonstrated abilities or actions (via the newly accessed medium of technology) that were previously absent from his repertoire of behaviors.
EVIDENCE: Interviews: Mo, p. 5; T3, p. 6; PT, p. 5; PP, pp. 6-7; OIS, p. 6

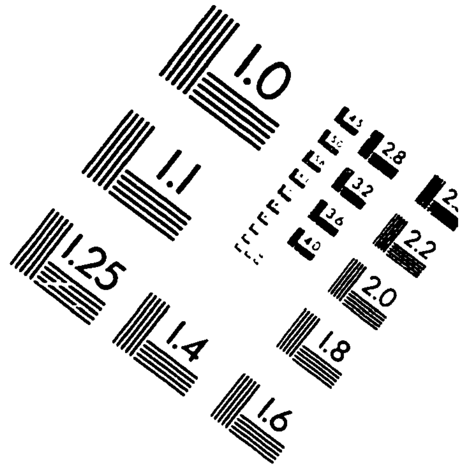
2) While there was little evidence that technology use changed the goals on Travis' yearly IEPs, expectations of staff members, family, and others involved in Travis' life were played out daily in the small, immediate interactions in student life. These interactions were beginning to show some indication of changes in expectations. Technology, when used as a tool to assist more successful functioning, will continue to be a big part of those changes.
EVIDENCE: Interviews: PT, pp. 5-6; T4, p. 17

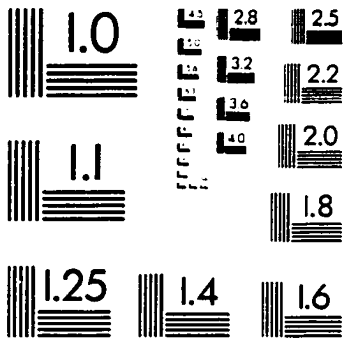
APPENDIX H
TRAVIS' ACCESS TO COMMUNICATION DEVICES AND MATERIALS
-SUPPORTING DATA-

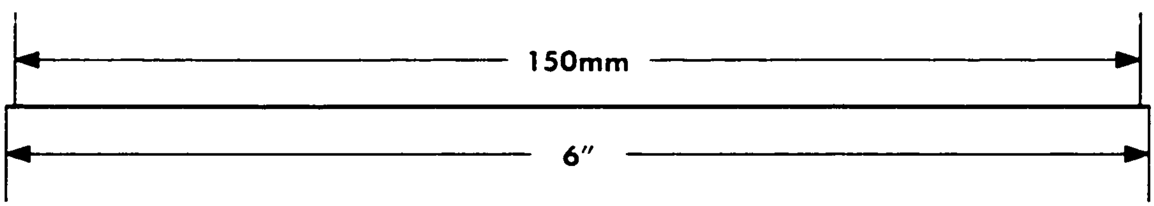
Label	Date	Total observation time (in minutes)	Icon access (in minutes)	Icon access % total time	Device access (in minutes)	Device access % total time
VO 1	10/9/95	30.00	0.00	0.0%	0.00	0.0%
VO 2	6/11/97	5.00	0.00	0.0%	0.00	0.0%
VO 3	6/16/97	13.00	0.00	0.0%	0.00	0.0%
VO 4	6/17/97	12.00	7.33	61.1%	7.33	61.1%
VO 5	6/19/97	30.00	0.00	0.0%	0.00	0.0%
VO 6	6/23/97	17.00	0.00	0.0%	1.47	8.6%
VO 7	6/24/97	24.00	1.00	4.2%	21.00	87.5%
VO 8	6/25/97	21.00	0.00	0.0%	14.00	66.7%
VO 9	7/3/97	8.00	0.00	0.0%	0.00	0.0%
VO 10	7/9/97	21.33	0.00	0.0%	0.00	0.0%
VO 11	7/14/97	30.50	0.00	0.0%	0.00	0.0%
VO 12	7/15/97	18.33	18.33	100.0%	0.00	0.0%
VO 13	7/17/97	36.50	2.33	6.4%	1.17	3.2%
VO 14	7/21/97	27.83	0.00	0.0%	0.00	0.0%
VO 15	7/22/97	27.17	0.00	0.0%	0.00	0.0%
VO 16	9/16/97	16.00	0.00	0.0%	0.00	0.0%
VO 17	9/22/97	8.92	0.00	0.0%	0.00	0.0%
VO 18	9/26/97	24.08	0.00	0.0%	0.00	0.0%
VO 19	10/2/97	6.33	0.00	0.0%	0.00	0.0%
VO 20	10/7/97	2.17	0.00	0.0%	0.00	0.0%
VO 21	10/9/97	0.00	0.00	0.0%	0.00	0.0%
VO 22	10/13/97	12.00	12.00	100.0%	0.00	0.0%
VO 23	10/21/97	8.50	8.50	100.0%	8.50	100.0%
VO 24	10/28/97	13.33	13.33	100.0%	0.00	0.0%
VO 25	11/4/97	7.50	7.50	100.0%	0.00	0.0%
VO 26	11/7/97	6.50	6.50	100.0%	0.00	0.0%
VO 27	11/12/97	11.67	11.67	100.0%	0.00	0.0%
VO 28	11/13/97	9.50	0.00	0.0%	0.00	0.0%
VO 29	11/18/97	7.50	0.00	0.0%	1.83	24.4%
VO 30	11/21/97	4.42	4.42	100.0%	0.00	0.0%
VO 31	11/25/97	7.33	7.33	100.0%	0.00	0.0%
VO 32	12/2/97	9.92	0.00	0.0%	0.00	0.0%
VO 33	12/4/97	2.25	0.00	0.0%	0.00	0.0%
VO 34	12/8/97	3.42	0.00	0.0%	0.00	0.0%
VO 35	12/11/97	20.67	20.67	100.0%	0.00	0.0%
VO 36	12/15/97	21.00	13.00	61.9%	0.00	0.0%
		TOTAL MINUTES Videotaped Total minutes 524.67	TRAVIS' TOTAL ACCESS to PIC. ICONS (minutes) 133.91		TRAVIS' TOTAL ACCESS to AUG.COMM. DEVICES (minutes) 55.30	
				Travis' access to pic. icons (Ave. % of time taped) 25.5%		Travis' access to aug. comm. devices of time taped) 10.54%

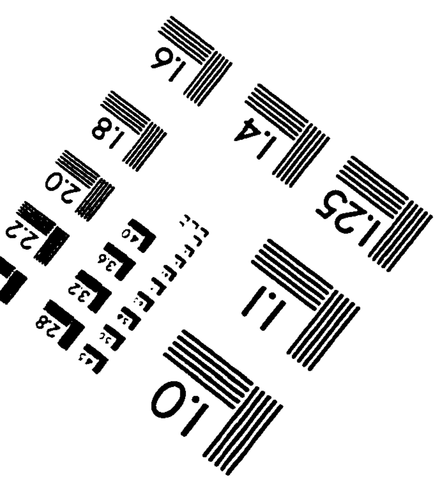
IMAGE EVALUATION TEST TARGET (QA-3)

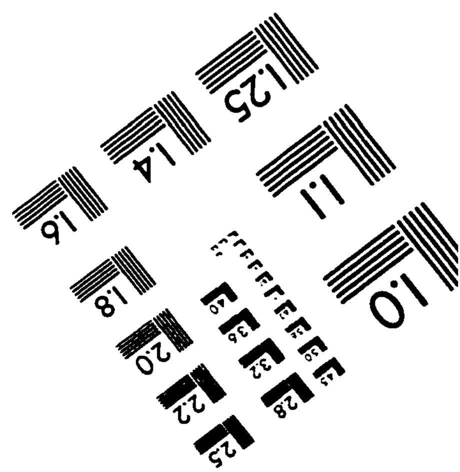












APPLIED IMAGE . Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989