A Case Study of a Cerebral Palsy Student's Use of a Computer

Roberta Thomson

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ABSTRACT

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Students with cerebral palsy have limited physical control of their movements caused by spasticity, dyskenisia, athetosis or ataxia. This thesis studies the uses made of a computer in the education of one seventeen year old boy, who has fairly severe physical and vocal restrictions due to cerebral palsy. The study took place throughout the school year of 1990-1991, at the Centre/Mackay Center, Montreal, Quebec. The method used was a single-subject action-research-case study. Through observation and participation, the process by which a computer is used as a tool in understanding the student, meeting his needs, and in assessing his capacity for reading English words, is documented. Qualitative methods including, cybernetic modelling and grounded theory strategies are used to record, describe, understand and evaluate what is going on in this environment. This study shows that the use of a computer in this environment can meet many of the diverse individual needs of the cerebral palsy student, and offer new experiences of control, self expression, interaction and independence. Also, the computer offerred a better method for assessing and learning English words. It was discovered that this environment can meet many of the educational objectives for the cerebral palsy student. It was found that coordinating communication among all those participating is essential to this kind of computer aided learning. The choice of appropriate computer software and accessing (hardware I/O) are also crucial to the effectiveness of such support for cerebral palsied learners.

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INTRODUCTION AND REVIEW OF LITERATURE

EDUCATIONAL PROBLEM

Cerebral Palsy is the result of lesions on motor centers of the brain which may occur before birth, during birth or after birth. The result being any one or a combination of the following:

-spasticity - uncontrolled muscular contractions,

-dyskinesia - rigidity and tremors in muscles,

-athetosis - uncontrolled jerky movements,

-ataxia - disturbance of balance and equilibrium.

The Canadian Cerebral Palsy Association estimates that there are 50,000 people in Canada who have cerebral palsy and Statistics Canada estimates 11,000 under the age of 14.

These students who, due to the effects of cerebral palsy, have a limited physical control of their bodies and varying degrees of ability to communicate in a vocal manner.

In an educational environment this poses many problems such as:

-there is little understanding of their needs or what they want. It is difficult and often frustrating for them to communicate their requirements. In the majority of cases it takes some time and patience for a person to become familiar with the individual student and his/her method of communication (e.g. using a Bliss symbol system and/or non-verbal cues).

-the resultant consequences, for education, of having little knowledge about the cerebral-palsy student is that there tends to be little understanding or a lack of clarity in understanding what these students abilities are (especially cognitive abilities). This <u>may</u> be partly due to the

failure or inadequacy or lack of present assessment methods. It appears that often not much experimentation is done beyond the standard assessment procedures. Such as the WISC-R and Peabody vocabulary tests.

-this in turn makes it difficult to provide instruction for these students because it isn't known where to begin. i.e. what their entry-level of knowledge or skills is.

These students bring with them an uniqueness that requires a learning and evaluational environment tailored to their individual needs. This is especially necessary initially, because a lot of information is needed about the students cognitively, physically, and affectively (motivation) in order to provide an appropriate beginning educational situation for the student. (A lot of experimentation needs to be done to get a good fit).

Fictional names are used for the student, the computer teacher and his classroom teacher, to protect the privacy of those involved.

In this thesis we will be looking at one particular student, Walter Torland, who is 17 years old during the 1990-1991 school year. He has athetoid and spastic cerebral palsy. There do not appear to have been any major academic goals set for him, only functional goals. (See Glossary for definitions of these terms). Although some teachers have recently (Sept., 1990) stated that it w uld be good for Walter to learn to read some English words (which would be an academic goal). From interviews, prior to June 1990, with occupational and speech therapists, the augmentative communication department, a student counselor, a computer teacher and one of Walter's teachers, it appears that he has a willingness to learn, wants to be in control of his environment, has a sense of humor and good spatial and association skills and a good awareness of his body. He has been driving

an electric wheelchair for the past three years and has limited vision as diagnosed by an opthamologist (he prefers using his left eye for viewing the computer screen). The problem is to determine what types of software, and computing access devices, and guidance really do help learners with these types of severe limitations.

RELEVANCE OF EDUCATIONAL TECHNOLOGY IN THIS ENVIRONMENT

The use of computer based techniques has relevance and pertinence to this educational problem because the technology often has the capacity to offer some solutions not otherwise available, or offer a way to understand the educational problems better. "Disabled people have special interest in new technology. Other forms of technology have helped them overcome their disabilities...It can help many disabled people to overcome barriers of time and space, and to a much greater extent overcome barriers of communication." (Hawkbridge, Vincent, Hales, 1985, p. vii) A simple example of a technology meeting the needs of an individual is the use of eye glasses for someone whose vision requires some assistance.

Potentially computer technology has the capacity and flexibiltiy as a tool to meet many of the diverse individual needs of cerebral palsy students. Thus making it a relevant and pertinent tool for this type of educational problem. It can be stated that people with cerebral palsy have 'normal' educational needs that are not met easily or readily by the current classroom practice and "sometimes we require special techniques and technology to help us meet our needs." (Goldenberg, 1979, p.4).

Aiding in communication seems to be one of the prime candidate computer uses with this population, but computers also help give access to education. "The computer provides a flexible technology that can so thoroughly enrich the experiences and communication of certain handicapped persons that activities and learning that were previously

thought impossible for them become routine and easy. By facilitating communication and activity for these persons, this technology provides a window into their minds that radically changes the picture we, and they, have of their abilities" (Goldenberg, 1979, p.5).

In this particular case study, it has appeared to several of the people who interact and observe Walter, that there is more going on in his mind than he has shown. The computer may be the tool to expose some of the thinking and skills that are present.

The area of assessment of students with cerebral palsy is one that needs some work. "Because of the cultural basis of conventional tests the intellectual potential of this group as well as its level of functioning out-side the test situation cannot be assumed to have been adequately assessed" (Saranson & Gladwin, 1958, p.141). This idea of cultural basis is important because most of the assessment methods are geared for students with a certain experience base that "most" cerebral palsy students don't have, therefore the assessment methods are biased towards non-cerebral palsy students. Another argument against traditional assessment methods is dealing with a communication factor. Geoffrion and Bergeron (1978) state: "Traditional approaches to testing are based on the assumption that the child is interested in bothering to answer questions on problems posed by the examiner. This assumption is very questionable when testing is undertaken with communication-handicapped children. Exploratory learning systems provide an environment wherein the child is more easily induced to demonstrate his or her cognitive skills." The use of a computer may help overcome this assessment problem as commented on by Goldenberg - "There is a serious need for assessment of process rather than prior

achievement. I think that using the computer provides an excellent instrument for assessing learning in process" (Goldenberg, 1979, p.157).

HISTORY OF COMPUTER USE WITH CEREBRAL PALSY

The use of computers with cerebral palsy people has been occurring for about 30 years with the main focus being on developing technology to assist with communication. "Electrical communication aids for the physically handicapped have been reported as far back as 1957 (La Voy, 1957) and continue to appear sporadically in the literature." (Goldenberg, 1979, p.5) In more recent years Greg Vanderheiden has done extensive work on non-vocal techniques for the severely physically handicapped.

There have been adaptive devices that have been developed in order to assist the cerebral palsy student with using a computer. These adaptive devices include mechanical language boards, sip/puff input systems, expanded keyboards, single-switch input, voice synthesizers for input and output, joystick controlled raster-scan and a light activated keyboard. It is possible to have the following parts of the body use sensory input/output devices - "head movement, head wand, eye, voice, breath, tongue, chin, arm, elbow, hand, finger, knee, toe and foot." (Willson, 1983, p.27)

The Tailor project at the University of Virginia has recognized that there are problems with the current accessing methods provided for Cerebral Palsy students. "The Tailor project recognizes that many disabled users have some repeatable, controllable range of motion, but that it does not correspond to any existing physical device." (Pausch, Vogtle, Conway, 1992, p.405) The software device that they created passively tracks the user's body motions and no strength is required to move a physical switch. This new method will offer even more hope for all cerebral palsy students to be accessing a computer when it becomes available.

These developments have helped give many students the possibility of accessing a computer. The variety of adaptive devices is a reflection of the variety of unique requirements of individuals and there may be many more that need to be developed to meet the needs of these individuals. Being able to access a computer may open up avenues of learning and education otherwise not experienced by many students with cerebral palsy. Many innovations have been developed where education is not the prime purpose, yet clearly computer technology can be immensely useful in enabling disabled users to gain access to education. (Hawkridge, Vincent, Hales, 1985, p.8)

There are many pertinent aspects of using a computer with cerebral palsy students. These include the following: an interactive computer environment can assist these students with communication, offer a form of self-expression, provide an environment that offers structure and freedom, provide opportunities of control and independence, and help overcome passivity and build self-esteem. The use of a computer may offer a window into the students' thinking process and it is important to use the context of the student along with appropriate goals. "Students, as they are increasingly posed with problems relating to themselves in the world and with the world, will feel increasingly challenged and obliged to respond to that challenge. Because they apprehend the challenge as interrelated to other problems within a total context." (Freire, 1973, p.68)

In the Tailor project at the University of Virginia (mentioned earlier) they are using a variation of the arcade game, Pong. The player has a one-dimensional control of the paddle but requires quick two- dimensional perception and planning to do the task. This project eventually wants to use

this type of input to control a speech synthesizer. Thus giving the students a chance to demonstrate skills as well as experience control. "By using this two-dimensional game we make the point that our target population has the planning and cognitive skills necessary." (Pausch, Vogtle, Conway, 1992, p. 407) For most of the Cerebral Palsy (CP) students this project has given them their first real-time continuous task that they've ever performed. (A large number of CP students drive electric wheelchairs which are not analog devices and the joystick must be moved far enough in one of the four directions to move the chair). (Pausch, Vogtle, Conway, 1992, p. 409)

An educational concern with these students is the question of whether the lack of voluntary motor activity has had any (or what type of) effect on the cerebral palsy childs' cognitive and perceptual development. Bruner, Kephart, and Piaget have postulated theories questioning a possible correlation between the development of knowledge and ones' ability to control motor activity. Marilyn Jean Buzolich has suggested that cerebral palsy children exhibit disordered rather than delayed development. (Buzolich, 1986, p.3) The computer is the ideal tool for controlling objects by command and thus opens up new possibilities for research. "By giving the older handicapped child access to the computer, not only do we see his initial abilities, - a measure of the effect of growing up without control - but we get to study the profile of his continuing learning, a profile that may yield information of great importance not only for the handicapped child, but also for cognitive science in general." (Goldenberg, 1979, p.48)

As well as hardware developments there are changes that have been made to software to adapt to the needs of the cerebral palsy child. These include differing scanning techniques associated with various input devices

and various forms of interactive programs. Cerebral palsy children can benefit from immediate and continued feedback in programs that help to keep their motivation high. "They also delight in any opportunity to exert control over their environment - a control, unfortunately, that their physical disability often denies them." (Summers & Gammon, 1987, p.134)

For many people with cerebral palsy their main form of communication is through an augmentative system called Bliss symbols (see Glossary). There has been computer software developed that uses Bliss symbols. "Technological developments have made it possible for individuals to remain with one graphic communication system, Blissymbolics, gaining security and expanding their world knowledge through having a strong, consistent framework on which to build." (McNaughton, 1989, p.13). There has also been developed a system called Blisstel that assists Bliss users in communicating via the telephone. "The goal of the project is to allow Bliss users to talk directly to each other with the help of computers, either face to face or at a distance, without always having to rely on an interpreter." (Finn, 1990, p.10)

Shirley McNaughton is looking at the issues of Bliss symbols and literacy. She is looking at what is involved in supporting the transition from Bliss to traditional orthography. It is expected that in the near future there will be some new software out called StoryBliss which will assist in this transition.

It has been recommended by Goldenberg (1979) that future research include a focus which adequately understands the needs of those with cerebral palsy . He also states that one of the biggest advantages for physically challenged individuals using a computer is in the area of control. "As

liberating an experience as it is to gain new control of oneself, it must have even greater significance to see that one can immediately use this self-control to have predictable and desired effects on one's environment" (Goldenberg, 1979, p.126).

JUSTIFICATION AND RATIONALE OF THE RESEARCH METHODS

This thesis is based upon a single-subject action-research-case study with the student Walter Torland. The focus here is to document (through observation and participation) the process by which a computer is used as a tool in understanding him, and meeting his needs. There is also a concern to examine attempts to assess the subject's capacity for reading English words and other academic areas via computer as they arise in the process (i.e. numbers).

According to Yin there is a distinctive need for doing a case study if there is a desire to understand complex social phenomena in a real-life context. (Yin, 1984, p.14) My rationale for doing a single-subject design is that the individual needs of cerebral palsy students vary greatly and in order to fully appreciate and do justice to the uniqueness of a student, a single-focus is necessary. The exclusive interplay of variables that comprise the learning situation of a cerebral palsy student may be such that by studying these students as a group, a true and optimal appreciation of these variables would be less visible. And it is the understanding of process variables (phenomena or basic concepts that function in the environment) that may allow for generalizations to be made to other learning situations of cerebral palsy students. It is hoped that the methods chosen will do justice to Walter and this environment.

The inherent nature of this educational situation is complex. One which may take a duration of time with careful observation and participation in order to attempt to understand the true reality of it. Qualitative methods, cybernetic modeling and grounded theory strategies

are used together because I think they are relevant to this educational situation and the research questions.

This area of education is sometimes referred to as "special, exceptional or rehabilitative" by some authors. There may be difficulty in using quantitative methods to adequately represent the human conditions of people who live in "extraordinary" conditions. "High priority should be given to applied, problem-oriented research which elucidates the actual development of the special education client and evaluated the programs and processes of special instruction and education". (Guralnick 1973; Goldberg 1974; Mittler 1975; Wolf 1979; Muthard, 1980).

A main emphasis of this research needs to be on the process. Process meaning is what happens and develops over time as the data is collected, interviews are taken and perceptions and observations are gathered. These all are important factors in gaining an holistic understanding this specific social and educative environment. "A key consideration is that human action and behavior can be understood only in terms of how the participants perceive and understand specific events." (Hegarty, 1985, p.111) By studying the processes and perceptions that take place in this research and understanding a holistic picture of the environment a more just picture of the student Walter Torland and his educational reality is hopefully possible. "Qualitative research has the natural setting as the direct source of data and the researcher is the key instrument." (Schindele, 1985, p.15) An understanding of this natural setting is important as there are many variables that interplay in this educational setting of a cerebral palsy student and it is important to know what that interrelationship is.

The use of educational cybernetic modeling and grounded theory practices together assists in satisfying the above mentioned concern for an holistic and therefore more accurate picture of this reality. The educational cybernetic model looks at processes that take place in the environment and the 8 possible variable classes which interact in this environment. (See Cybernetic system picture, Figure 1.)

The use of grounded theory techniques also assists in ensuring the accuracy and reality of the data that is gathered. "...a theory must have fit and relevance and it must work. Grounded theory meets these criteria because it is generated systematically from research data...a theory must be readily modifiable, based on ever emerging notions from more data. Grounded theory meets this criteria also." (Glaser, 1978, p.40) Another reason for using the grounded theory approach is because it can assist in the understanding of the complexity of social phenomena. "This is why grounded theory methodology emphasizes the need for developing many concepts and their linkages in order to capture a great deal of the variations that characterize the central phenomena studied during any particular research phenomena ." (Strauss, 1987, p.7) See the chart showing the Relationship of Categories, Table 1.

I feel that the use of action research is vital because "Action research usually employs the highest level of reality and the least amount of precision". (Borg, 1967, p.20) By having little control of the specific long-term events this allows for modifiability and adjustments that can be done based on new insights as the process continues. Thus giving a high degree of reality to the research. When working with a cerebral palsy student there can be many adjustments that need to be made as more is known about the

individual. Thus a cause and effect cycle takes place and continual modifications to the processes can be made based on the needs of the student and those involved.

The idea of action research can be taken one step further - to that of "action science". "Action science is an outgrowth of the traditions of John Dewey and Kurt Lewin". (Argyris, Putnam, Smith, 1987, p.6). Dewey criticized the traditional separation of knowledge and action, and hoped to have an integration of science and practice. "This observation that experimentation in science is but a special case of human beings testing their conceptions in action, is at the core of pragmatist epistemology." (Argyris, Putnam, Smith, 1987, p.6). It is my intention through action research to have an integration of knowledge and action. The knowledge obtained is constantly being understood and applied to aid in the new practices in the environment.

"Lewin was committed to the kind of science that would improve social practice, some of his themes included the following-

1 - Action research involves change experiments on real problems in social systems. It focuses on a particular problem and seeks to provide assistance to the client system.

2 - Action research, like social management more generally, involved iterative cycles of identifying a problem, planning, acting and evaluating.

3 - Action research is intended to contribute simultaneously to basic knowledge in social science and to social action in everyday life."

(Argyris, Putnam, Smith, 1987, p.9)

The study environment of this research needs relevant data upon which to base its analyses and conclusions. And by enacting action oriented

research more relevant data can be uncovered. "The contemporary view is that understanding action is like understanding a language. Like sentences in a particular language, actions make sense in a particular community of practice and the competence required to understand action is acquired with membership in the relevant community." (Argyris, Putnam, Smith, 1987, p.24)

So by being a participant-observer in the cause and effect cycle of this process one can hope to be able to attain an understanding of the actions in this educational community. The amount of time spent, and the participatory experience gained, in this environment should provide the insights needed to adequately understand this environment.

METHODOLOGY & APPROACH

DESCRIPTION OF TECHNIQUES

The techniques used were: data collected using "open coding" (see Glossary) from interviews, observation of the process, my participation in the process, and triangulation (see Glossary). "In the naturalistic tradition, the prime sources of data are the words and actions of the people you are interviewing or observing, and are recorded mainly through written notes." (Lofland & Lofland, 1984, p.47) My rationale for using this type of methodology is that when qualitative research does not use an a-priori theory it is open to the discovery and development of theory based on reality. I attempted to uncover the reality of this situation as it unfolded naturally. I think that the form of a case study is necessary because it can provide the opportunity to give the necessary attention to one particular student.

The ideas expressed in the conclusions and contribution sections are what shaped the focus of the research. These ideas were developed from reading of the literature and experience during a 90-hour internship during 1989-1990. Having had the experience of the internship and also working with many of these students in aquatic and camp settings I have developed a personal interest in this environment. "'Starting where you are' provides the necessary meaningful linkages between the personal and emotional on the one hand and the stringent intellectual operations to come, on the other." (Lofland & Lofland, 1984, p.10) The data collected will also be directed towards getting an holistic view because human behavior is often inexplicable without contextual meanings and hence an educational

cybernetic model is developed. It was intended that the richest possible data be collected. "Rich data mean, ideally, a wide and diverse range of information collected over a relatively long period of time." (Lofland & Lofland, 1984, p.11) And according to Lofland & Lofland that collection is achieved, again ideally, through direct face to face contact with, and prolonged immersion in some social location or circumstance. (Lofland & Lofland, 1984, p.11)

Strauss and Glasers' grounded theory methods of coding, memoing and conceptual elaboration are used, with a desire to develop an emergent theory to fit the data. The results of insights obtained as events unfolded employ the cause/effect technique of action research.

The directed graph matrix shown in Table 1 was developed as a method to display the summary of the relationships of all the categories within this educational environment. The categories are those that were developed after careful analysis of the data collected in my field notes. First, the main concepts were stated and then compared with my notes. (Note - after a concept has been shown to have a constant and significant appearance in the data, I call it a category). Each concept was elaborated by looking at the conditions surrounding it, the consequences of this in the environment, what interaction takes place between people related to this concept, and what are the strategies and tactics used around it. I then studied the influences each category had on the others and exhibited this as their interrelationships in the directed graph matrix.

INITIAL EXPECTATIONS OF THE RESEARCHER

My expectations as a researcher were:

Expectation - I would be able to collect data to draw conclusions about the use of computer in this environment with a CP (cerebral palsy) student.

- be an accepted participant-observer with Walter, people would be co-operative and my input will be received.

- those involved would willingly answer questions and provide information when necessary.

- I would attend 3 - 4 session per week.

- conclusions would develop slowly as the the result of the process.

- using the computer would be a liberating experience for the CP student.

- using an applicable context would be helpful for Walter.

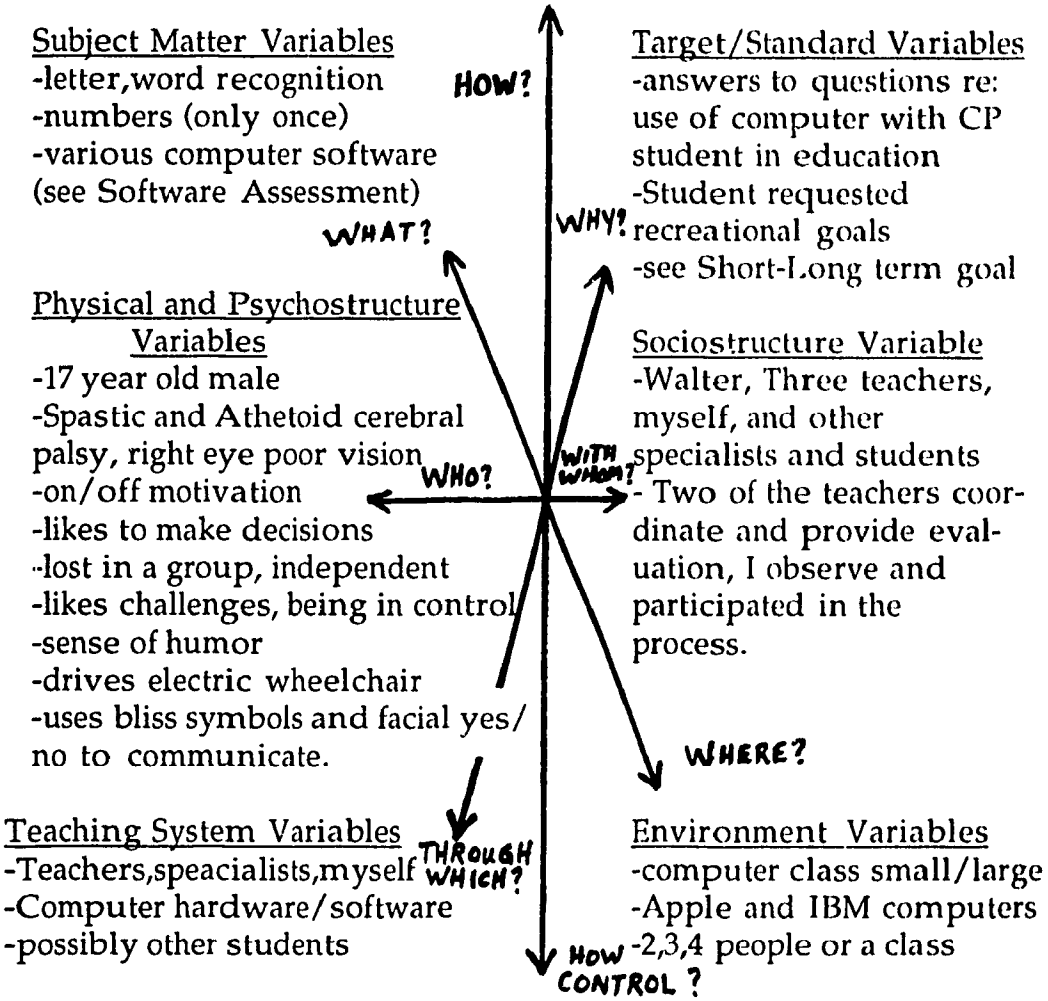
ROLES OF THE COMPUTER TEACHER AND CLASSROOM TEACHER

Heather is the computer teacher and her role in the computer classroom is to experiment with new software and accessing methods with the students. In February 1991 she became concerned about her goals with students and brought this up at a staff meeting. Please refer to the Descriptive Observations and Interpretations during February 1991 for further discussion of Heather's concern about her role.

Dana is Walter's classroom teacher and her role with him is to work on academic and functional goals in a regular classroom setting. She works with him once or twice a week on these goals, using the computer software and accessing tested by Heather.

FIGURE 1 - CYBERNETIC VARIABLE CLASSES IN AN EDUCATIONAL SYSTEM

Teaching Algorithm
(method/strategy)
-try software (see Larger relationship page)
-assessment first, depends on teacher
-possible repetitive situations to measure learning, using various software such as First Letter Fun, Reader Rabbit, Wordburner



Learning System Control Variables
Learner Walter
-little is known of his prior knowledge except from WISC-R and Peabody Picture Vocabulary
-characteristics - control, challenges and his choice
-learning algorithms (step by step techniques used to learn by the student) One clear occurrence in use of

Reader Rabbit matching game. He would turn over the last one he had seen and then continue. He is also dependent on the teacher for prompting and assistance. In other programs there isn't any strategy.
-his willingness to learn is high, he's not passive
-he seems to apply what he knows as seen by his driving his electric wheelchair and asking to have repairs done on his wheelchair.

(after Frank & Meder, 1971, p.36)

RESEARCH QUESTIONS AND TENTATIVE HYPOTHESES
(made prior to case research study)

Research Questions

1 - what are the special characteristics and the ways computers and software can be adapted to enable and enhance the education for cerebral palsy students?

2 - can computer software and hardware help in the assessment and evaluation of a cerebral palsy student.?

-how can computer software assist with assessing and cognitive development of letter and word recognition? (small letter and capital letter) Also, the transfer from Bliss symbols to the equivalent words.

-are there other areas that come up in which computer software can be used as a tool for assessment i.e. with numbers

3 - can one learn much about a cerebral palsy child by using computer software?

4- what are the students and teachers feeling in this environment? what works best for the feelings of this student? Why are the things being done in this environment?

Focal Ideas

The focal ideas are based on the fact that those who are working with Walter have an understanding of his communication style and that this is provided for when he is using the computer.

The focal ideas I formulated and used, concerning the student and others that interact with him and this educational environment, were:

1 - the computer hardware with software can be a useful tool in an educational environment with cerebral palsy students by offering new ways for self expression, control, interaction and independence (the literature supports this). This may foster other positive consequences i.e. friendships.

2 - the use of the computer as a tool including the software can provide ways to better understand the cerebral-palsy child -

-the computer environment might give the student a forum where he can directly show what he likes and does not like (self-expression of needs and wants)

-the use of the software may expose patterns of thinking used by the student

-provide new ways for understanding how a non-verbal cerebral-palsy child communicates and may provide new ways for communicating.

-through gained knowledge about the students abilities and desires, appropriate educational goals can be made that suit the student.

3 - the computer as a tool with software provides opportunity for motor learning experiences and an environment where the student has the opportunity to be voluntarily active and interactive.

4 - that appropriate accessing methods are necessary for the cerebral palsy student and are a vital first step in using the computer. This is a crucial step in the effective use of a computer.

5 - using contextual data with Walter is vital to providing a valuable educational environment for him.

INITIALLY EXPECTED CONTRIBUTIONS OF THIS STUDY

What contributions do I hope to make by this study?

Generally:

-uncover information about a particular cerebral palsy student that will aid in the further understanding of what is needed to make a good educational situation possible for him and other cerebral palsy (CP) student

-help people understand the process involved in using the computer in an educational environment with CP students?

Locally:

-help people at Mackay know whether Walter can recognize words and letters? and to what degree is he able to do this?

-provide information to help formulate new educational goals for Walter and provide any information that may contribute to better communication (interaction) with him.

-is there any pattern to his learning? and what is his learning style?

-summarize what has been uncovered about Walter through this process?

-try to provide information based on an holistic view of Walter.

-what is a good context for Walter that enhances his desire for learning?

-generalizations could be made for other CP students using computers

OBSERVATIONS, DESCRIPTIONS AND INTERPRETATIONS
Story from September 1990 - June 1991

This story is made up of five types of narrative. These will be interspersed with each other with the majority of this story being a description of what happened. This and the other types, as explained below are outlined, and shown in single space.

1 - The first type of narrative is called connecting narrative and coded with an "N".

2 - The second type of narrative is a description of what I saw during the time I spent with the student and is called observations and coded with an "O".

3 - The third type of narrative is the treatment that was used in a particular session and is coded with a "T".

4 - The fourth type being other peoples' reports of what was happening during this time and is coded with an "R".

5 - The fifth type are any questions arising from a session and is coded with a "Q".

6 - The sixth type being prescriptions made by either the staff or myself, based on what has been taking place and is coded with an "P".

7 - The seventh type is my interpretations of what I saw happening during the sessions and is coded with an "I"..

8 - The eighth type being any cross-validations of my interpretations and what others saw and is coded with an "XV".

It may be useful for those unfamiliar with terms common to this environment to refer to the Glossary. The software that is used over the year is summarized in more detail in Appendix C.

The idea for this case study was developed out of the experience of my internship during the winter of 1990 in the computer classroom at the Mackay Center. In order to explore the idea of doing a case study with the student Walter Torland I had interviews with several people in the spring of 1990. These included Walter's computer teacher, classroom teachers, school counselor, occupational and speech therapists, augmentative communication person and a specialist that worked in this area in a different school. In talking with Walter's current computer teacher at Mackay with whom I did my internship I determined that it was feasible to do my thesis there, working with her on Fridays during Walter's exploratory computer time and on Mondays with one of Walter's classroom teachers who was using a computer to explore certain skills.

A brief summary of Walter Torland is as follows: He is 17 years old and has been at the Mackay Center since he was 5 or 6 years old. Physiologically he has cerebral palsy - choreo athetosis (uncontrolled movements) and spastic quadriplegia (tightness in muscles) and somewhat limited vision, with his left eye having the best vision.

The following characteristics of Walter were compiled from several interviews conducted in the spring of 1990 (other peoples' reports):

(R) - he has good spatial awareness and organizational skills

- he has good body awareness

- he is independent, likes to be in control and take an active part in his learning

- he has an unwillingness to use all that he knows i.e. he knows 256 Bliss symbols but uses only a limited number of them and sometimes no more than 2 at a time.
- he has on/off motivation
- he tends to get lost in a group and will become passive
- he needs to be challenged and his strengths channeled
- he has difficulty with math concepts
- he is good at oral associations
- he is good at associations between actions, locations and objects
- he has good receptive vocabulary and visually complex discrimination of pictures
- it is questionable how productively his time is being used in reference to functional and academic goals (see Glossary).
- sometimes he may give the impression that he recognizes a word but that is because he has memorized where it is spatially, and he has not visually recognized the word.

(O) In using a computer prior to the fall of 1991 there have been several developments and concerns which were compiled from my internship during 1990. These are:

- Walter's vision is limited and his left side vision is better than his right
- the following accessing methods have been tried: using the AFC/ Unicorn keyboard, a rotary mouse with his left hand (but his hand tends to slide off the mouse), a joystick, and a single switch
- he responds well to verbal commands and to the sounds from the computer

- he likes using the touch window
- he likes interactive programs
- he seems to show good eye-hand coordination with computer programs that have simple screen displays
- when using LOGO he seems to like alternating turns with another person
- finding tasks that are appropriately challenging for him is necessary because he gets bored if not challenged.

(P) Two prescriptions that have come out of these reports and internship are: (a) as a result of not having adequate assessments available then one prescription is to find out what Walter knows of words and letters using various computer programs, (b) and find tasks that are appropriately challenging.

(N) Walter is a non-verbal student whose main form of communication is through the use of his book of Bliss symbols located on the tray of his wheelchair, he will also communicate by responding yes/no with a head nod or head shake and, movement of his eyes.

(O) In September of 1990 I began to participate and observe in the educational process with Walter Torland. The fall of 1990 started with a review of Walter's Individual Pupil Plan (IPP) done in January of 1990. The main goals arrived at were for Walter to work on his reading and writing skills, increase his sight word vocabulary, increase the number of programs he can use on the computer. (See Table 2 of Long and Short term objectives in Appendix A). Also, Walter will learn to accept his need to wear his right hand splint to improve his ability to use his Bliss display and the computer.

On many occasions he will not want to wear his splint because it restricts his movements and makes him different from many other students.

The classes in the fall began with a focus of developing appropriate accessing and, the assessment of and exploring Walter's learning of English words. Walter has made a request to do recreational games. (T) On September 30th the first software explored were Interactive Games (see Glossary) that required two people to play. The accessing was using a single switch mounted on his wheelchair on the left side of his driving control. This seemed to be good for him but the scanning (timing of the cursor) in several of these programs was too fast for Walter to adequately respond to. (Q) There also was a question as to how well Walter could see the screen?

Heather whose role as the main computer teacher, is to experiment with new software and try to find appropriate accessing methods for the students. (O) She tried to incorporate the reading aspect by putting the names of these games on a large sheet of paper so that Walter would have to read them and he could then choose which one he wanted. This would be done by another person pointing at each item on the list and getting Walter's yes/no response to each item.

(I) I interpreted from this session that because he showed a continual desire to compete and interact with others that he likes this context where he can play games with other people giving him some competition and human communication.

(T) In mid-October two new single-switch programs were introduced called Binary Writer and Davey's Digits. On October 15th the program Binary Writer was tried. It is a piece of software which uses single switch

scanning of the alphabet. It is possible to set up lists of words under each letter. For example under the letter "G" a list was set up of the games that Walter knows how to play. Then if Walter selected this letter he would get the list and have to visually recognize the word of the game in order to choose it. (That was the intention of this being set up). Later on in the month a list words were set up that included both Heather's and Walter's names.

(O) My observations are that when using Binary Writer there is a menu in which all the software on the disk is listed and the teacher usually does the selecting using the keyboard. In almost all of the cases the student does not participate until the actual program is selected this reduces the level of independence and control the student has of this process.

(T) On October 22nd the program Davey's Digits was tried. It is a program that is focused on number recognition. It has two options - simple counting where the person enters a certain number of taps using the space bar and the program responds with the corresponding number on the screen, the second option is matching where the process is reversed (a number is shown on the screen and the person must respond with the appropriate number of taps).

(R) A teachers' observation is that when looking at this program it was realized that Walter doesn't have numbers in his Bliss book and that it is really unknown as to how many numbers Walter really knows.

(O) During the rest of the month of October, while using the matching part of this program, it was shown that Walter seems to know the numbers 1 and 3 and has some difficulty with 2, 4, & 5, quite often mixing up the

numbers 2 & 5. Heather provided verbal input while doing this program by stating to Walter what the number that was shown on the screen.

(T) Also, in mid-October (October 19th) some special IBM-Equipment was tried with speech controlled software called Speechviewer. There were various games available which were controlled by the persons' speech. For example a balloon on the screen gets bigger with increased vocal sound (as the person speaks into a microphone) and the picture of a clown whose mouth gets bigger with increased sound. This program also records ones' voice on a graph showing the pitch of the voice. This is recorded and the vocal sound graph is played back with the corresponding voice sounds. (O) Walter really liked this aspect and chose this when given the choice of any of these he could do.

(I) My interpretation of this session is: This computer software provided Walter with a totally new and more powerful experience of control. Walter probably had never experienced controlling anything by using his voice, and also has never heard what his voice sounded like.

(O) On many occasions Walter complained about using the Binary Writer program. This is possibly because the screen was somewhat hard to read (the words were in small print and close together) and the software was rather bland comparatively speaking with other pieces of software. He did not find it that enjoyable and opted for playing the single-switch games such as Tic-Tac-Toe and two versions of bowling. (O) Walter really likes the bowling programs and they appear to offer experience in eye-hand co-ordination. Accessing is at times difficult because of the need to time the hitting of the switch with the visual movement on the screen.

(O) At the beginning of November Walter's baby brother was born and as a result Walter was very excited. He wanted to communicate this news with everyone and it was necessary for him to do this before he would begin any ordinary class work. In one particular class on November 5th, Walter refused to participate in anything and he even responded "no" to the question "Do you ever want to use the computer again?". This last question was probably in the hope to get Walter to say "yes" and then they would be sure of one point where they stood with him. This caused a lot of confusion for those working with him. We were very concerned with understanding him and taking what he says and wants very seriously. (Q) This became a crucial event in the overall process and produced the global question of "What are we doing with Walter?".

(T) At this same time (Nov. 5/90) Heather wants to try to co-ordinate what she's doing with Walter's primary care worker in residence, by giving him a copy of Binary Writer (she still feels this software has potential), as he spends a good part of the day with Walter and co-ordinates his work on the computer during this time. One of her aspirations is to meet Walter's needs as Walter is growing and she recognized that what he needs may be more than what has been planned for on his IPP. (O) Walter's needs are determined by observations, informal assessment and if Walter states something in particular that he needs.

(T) Heather has been experimenting with the use of LOGOwriter with the intention to allow Walter to draw using keys on the keyboard. This would possibly give him more freedom to express through this program, as long as the accessing with the keyboard was successful. (O) This seemed to work quite well and Walter drew straight lines with colors. (T) In this same

session Heather experimented with Walter using the joystick as input. (O) This was hard for Walter to control as it is hard for him to co-ordinate his hand movements with the directions of the cursor on the screen but Walter seems to be showing interest in using the rotary ball (trackball) with this program.

(I) After the "scenario" of Walter not wanting to do anything, many more ideas began to be discussed. My interpretation of this, is that this appears to be a critical event in the overall process of this year and those working with him wondered what would be available to him in the future in the way of what type of hardware will be available. Other people's interpretations are: A person who has worked with Walter in Augmentative Communication stated that Walter usually has a slump during this time of year and that along with the birth of his brother caused a combinational effect of Walter being unmotivated. Walter's primary care worker has informed Heather that Walter is particular about what he does with whom and that he likes to be in control. He wants to use the regular keyboard and likes to have free reign over what he does.

(T) On November 19th, Binary Writer was tried again using a list of names that he is familiar with. This is done to increase his sight vocabulary. (O) Again Walter was not really interested and the focus was shifted to recreational games of Tic-Tac-Toe and "Green" bowling (in which the bowling alley is horizontal on the screen). The timing is sometimes difficult for Walter in the bowling game because it requires quick eye-hand co-ordination to hit the switch at the time when the ball is in a good position to knock down the pins.

(N) November was concluded by a positioning session, on November 26th in which two teachers, an occupational therapist and Walter's Primary care worker were involved in assessing Walter's accessing at the computer - an Apple IIgs. This computer has the important feature of a moveable

keyboard. (T) The focus was on using this regular keyboard on different levels of tables and the monitor on different levels. A keyguard was placed on the keyboard to help Walter with control hitting the right key with out slipping onto another key. The scope of his vision is questioned. Placing the monitor on a flexible table was intended to ensure that he is able to see what is on the screen. (O) In the session following this one on November 30th, Walter showed a direct interest in using the different tables and using the MacIntosh computer as he went directly to it and started hitting the keys. A larger keyboard with large round letters, propped up on a wedge to give Walter the right angle for him to be able to hit the keys was used.

(P) The prescription was made of using a larger keyboard with large round letters, propped up on a wedge to give Walter the right angle for him to be able to hit the keys. (O) This was tried with an Apple computer and Walter could see the screen but Walter didn't have his splint on, so it was not successful and this was not tried again with the splint as it should have been.

(P) Another prescription that came out of this positioning session is that it is better for Walter to use his right hand when using the keyboard and that he needs to have his splint on his right hand to prevent further contractures of his wrist. This was recommended by the occupational therapist.

(N) December began with Walter using the new adjustable table (see Figure 2) and indicated how well he can see the screen. Heather stresses that he needs to face straight on to the computer because Walter has a tendency to want to use only his left hand and sit with his left side at the computer. This may be possibly due to his left eye having better vision but the flexibility of the new table was intended to alleviate this need. (O) I observed that using the flexible table did alleviate this need for Walter to use his left side only. But when a different computer was used that didn't have the

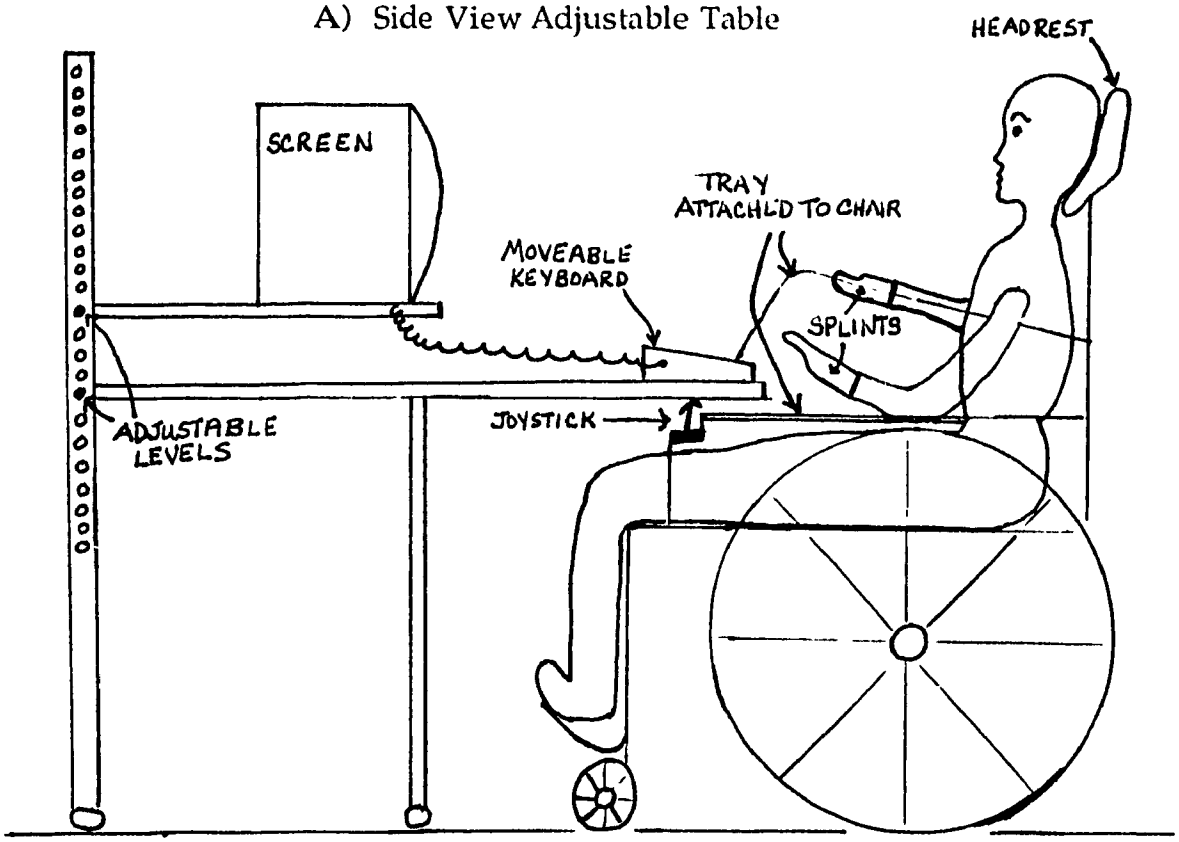
flexible table then Walter would often begin by using just his left hand while sitting with his left side near the computer.

(P) The occupational therapist has made a prescription that it was not beneficial, physiologically, for Walter to sit using his left side only. (O) This causes him to stretch his neck and arms in positions that hinder the proper alignment and strengthening of his muscles. It is preferable if he sits facing the computer as shown in Figure 2.

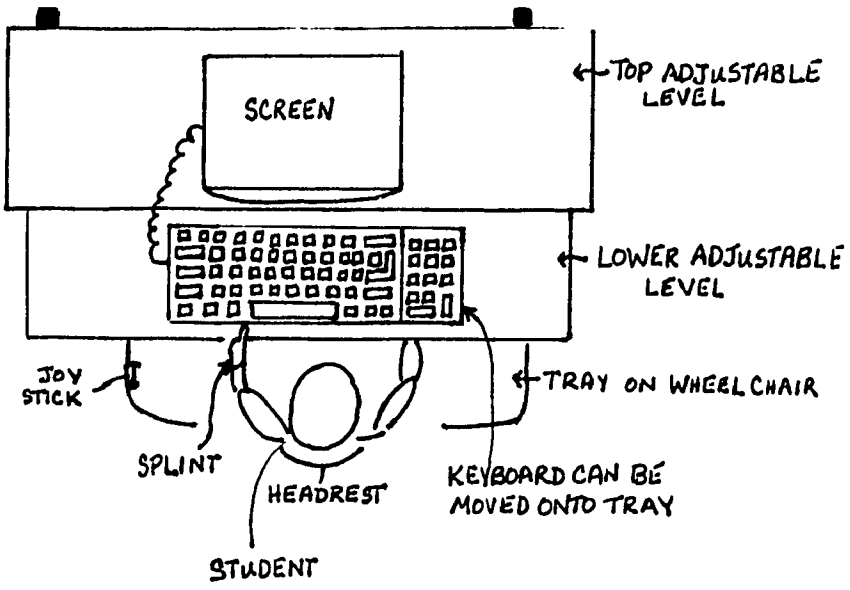
(T) A new program called First Letter Fun has been introduced as a tool on December 3rd, to assist in the reading of English words and also because it has a section that deals with farm words. Walter has a familiarity with farms and it is thought that by using material from his won background context would be beneficial to his learning process. Walter used this program with the keyboard placed on a inclined wedge and the keyguard was on. (The wedge was sloped so the back of the keyboard was raised about one inch higher than the front of the keyboard). (O) After some use it turned out that it was better not to use the keyguard.

FIGURE 2 - PHYSICAL ERGONOMICS

A) Side View Adjustable Table



B) Top Down View



(I) My interpretation of what is happening during this session is that Walter seems to like this program and that it may be a good one for assessment and learning because of a screen display that includes a lot of movement and sounds (which Walter likes).

(XV) At the end of May one teacher said, after using the program Wordburner, that the computer would probably be used as tool for assessment for learning. This is a cross validation of what I've observed here in the use of this program First Letter Fun.

(P) The use of words that are contextual to farms is a prescription made by those familiar with this student and based on their interpretations of what is important and relevant to him.

(O) Walter has been showing a lot of assertiveness as he goes directly to the Apple IIgs computer when he enters the classroom and starts typing on the keys. This was especially obvious on December 7th. (O) Heather continues to work with LOGOwriter expanding the area on the keyboard to reduce the possibility of Walter making mistakes. Also, the keyboard is being expanded so that Walter can draw with his right hand. Walter seems to like this and is motivated. Heather wants to transfer some games to the LOGOwriter format.

(I) An interpretation made by a teacher is that the facility of accessing varies with each task and that improving accessing skill is a big part of the process. (important!!!)

(T) During December, First Letter Fun was used once with the Apple IIe while Walter was facing left and using his left hand. Since this is not a great idea physiologically he was switched to the Apple IIgs where he sits straight on but there may be some difficulty with his vision when accessing it this way. (O) Walter wanted to work on the park words and seemed to enjoy this. The co-ordinating teacher interacted with Walter and the program by

pointing to the picture on the screen and saying the word orally as well as the sound of the first letter. Walter also appears to be showing good control in using the keyboard on a wedge with LOGOwriter while facing straight on to the computer. He is good at pressing the delete and option keys and Heather would like to try this on the IBM because maybe the screen is better visually because it has a higher resolution.

(T) One final significant event of 1990 was on December 17th, was that a new page was put in Walter's Bliss book with a menu grid of the names of activities he can do on the computer. These include Games, Aquarium, Bliss, Kidwriter, Draw, Farm, IBM Kidwriter, and Music. (O) When asked if Walter likes to make choices he says "yes" and chooses the "farm" from his new sheet.

(R) One of his teachers' understanding is that sight words are the way to go with Walter and that he needs a larger vocabulary in order to tell about his things, such as what he did on the weekend.

(P) A prescription was made to give him choices and hence empower him. Putting this page in his Bliss book will allow him to indicate his choice of what he wants to do. (important)!!

(I) This idea of giving him choices thus gives him control.
(XV) This can be cross-validated by all the instances where I and others have observed that Walter likes to experience control. For example in the use of the Speechviewer program Walter experienced control by using his voice and in the Aquarium program he has the desire to press the letter "S" thus giving him the ability to stop the program and control what is happening. He can visually see the results of his control by changes on the screen.

(N) The new year began on January 7th after three weeks off. Heather introduced a new program called 'Reader Rabbit' by the Learning Company that uses the single switch. The program has three parts - a sorter, labeler and matching. The sorter requires one to sort based on a specific letter sound. With the labeler one has to choose the corresponding first letter to

the picture shown on the screen (this has a focus on phonics). The matching section is similar to a concentration game where there is a grid of 12 squares and one has to find matches between the squares. There is an assortment of types of matching that can be done including matching picture to picture, picture to word, and picture to first letter. (T) During this explorational period, Walter tried the labeler section and Heather prompted him by saying what the word of the picture was and gradually lessened the prompting to just saying the letters. (O) The matching section was tried and Walter was quite good at this and he did not require further prompting.

(P) One of the teachers concluded with the suggestion that it might be worthwhile to try using the keyboard and an IBM screen because it offers better screen clarity and may offer better visual possibilities.

(N) Walter was sick for a week from January 11th to 18th, and during this time Heather, and Walter's previous Augmentative communication teacher, and his occupational therapist spent time planning for an APO conference in which they decided to feature work that had been done with Walter over the last few years, as their topic.

(R) A report of these people's comments in the meeting are as follows -

1) after having tried many types of accessing devices they were going back to using the Unicorn keyboard because they find this has the most flexibility,

2) Walter likes to have control,

3) the adequacy of communication with Walter and among the people who work with him are two issues,

4) using the single switch for recreation is a good thing since that will certainly be transferable to his future and life outside the classroom,

5) whatever motivates Walter will lead those working with him to discover other things that Walter can do,

6) accessing is very important and changes with the task, the person and the program,

7) when using the Unicorn keyboard one can vary the size of the squares and have access to more keys and different programs.

(P) This APO conference presentation concluded with two prescriptions - 1) use the Unicorn keyboard during class time and, 2) use the single switch for recreational games because it is flexible and easy to set up in a variety of locations.

(N) Also during this time when Walter was sick a small review was done by Walter's computer teacher and another one of his teachers. Their discussion focused on the use of sight words for Walter. (R) It was stated that Reader Rabbit is good for phonics and the matching section has the possibility of using many topics.

(Q) My question was, could this program, Reader Rabbit be used as a learning and assessment tool? (R) A teacher commented that the use of the program First Letter Fun may be a good learning and assessment tool as using the farm pictures seems to motivate Walter. (P) Hence she wants to set up an IBM AFC keyboard for this program to evaluate the input and see which areas are appropriate on the keyboard.

(T) The rest of January from the 21st to the 28th was spent trying to use Reader Rabbit at first on the IBM using the Unicorn keyboard. (O) Even though Walter initially wanted to do First Letter Fun - farm section. Using the IBM (Reader Rabbit program) proved to be a little difficult for Walter to

see the keyboard and the screen. They tried a big round single red switch and then a mouse and Walter really liked the mouse. Heather says she wants to continue using the Unicorn keyboard though. In using this program Walter uses the matching pictures to words and pictures to pictures. Walter seems to do really well at these and seems to have a strategy of turning over the last one he saw of the previous two he had turned over. One of his teachers prompts him by showing him where the cursor on the screen is and saying the word of the picture shown. (I) I noted that Walter seems to like and rely on this prompting by the teacher and when she doesn't give him the usual prompting he will look to her for it. Walter also had some distractions from what was going on in the adjoining class.

(I) I noted that when Walter is using the Unicorn keyboard his Bliss book is taken away and the only form of communication available to him then are yes/no questions which may not be adequate for his needs.

(R) During this same time period, Walter's Augmentative Communication teacher from the previous year said that using the computer helps to reveal Walter's capabilities, as it did by showing that he had spatial abilities.

Also, the occupational therapist says that it is really necessary for Walter to have his splint on at all times when he is using the computer.

(O) February began with Heather asking Walter many questions about what he wants. He didn't want to draw or do the LOGOwriter program but wanted to do the Farm program and said he didn't want to use the keyboard. Heather didn't want to accede to this and said she was a little confused about her goals. As she understood the goals, she was supposed to be trying

different types of software and accessing methods. Walter did not have his splint on and Heather said she would not continue until he had it on because this is a very necessary thing for him. At this point she did not explain or demonstrate why it is necessary for him to have it on.

(N) Walter continued to do the matching game of Reader Rabbit on February 4th & 11th, using picture-word and picture to first letter. He's done the animal, kitchen, outdoors and travel categories. One of his teachers would like to enter a set of words that are more directly appropriate (contextual) to who Walter is rather than to rely on the pre-given set. (O) In doing this program Walter sometimes has difficulty seeing the cursor when it is near the bottom of the screen. (T) When doing the matching of the picture to the first letter the teacher prompts Walter by verbally stating what the picture is and the sound of the first letter, and sometimes if the teacher knows when there is a match she'll show him where one of the pictures in the matched set is.

(P) A prescription from one of the teachers is the use of a learning strategy that is to tell what all the pictures are and their first letters are before beginning the program and then to reinforce the first letter sound of the pictures shown as the program progresses.

(Q) A staff meeting was held on February 13th that was partially initiated by Heather's concern for what her goals need to be with Walter. This meeting was attended by all those people who are involved with Walter on any level. The main questions addressed were -

How should decisions be made concerning what Walter will learn - the answer was what this was stated on the IPP. (Individual Pupil Plan)

What to do if Walter arrives without his splint on - the answer was to call one of his aides and have the aide come and put it on.

What is the use of the computer? Heather says she wants to use it as a tool to assist with real tasks. One of his teachers wants to use the computer to assist with his sight vocabulary & to assist with his communication.

What does Walter need?

(P) A prescription is that he seems to need structure and a clear cut lesson plan and he needs to learn to control his environment through effective communication. (Even though most of the time Walter rebels from a structured environment).

(Q) Another question is how many people work with Walter and who is in charge - It turns out that there are eight people who work with him and no one seems to know who is responsible. (T) Finally it was agreed that his home room teacher would be responsible.

Please see Appendix D for further discussion of problems arising during this time period.

(T) Things continued with Reader Rabbit on February 15th and 18th, as one of his teachers wanted to know if he knows the first letters. The same learning strategy is used as she walks Walter through the pictures and gives him the first letter sounds. She also points out where the cursor is on the screen as Walter sometimes has difficulty seeing it. (O) This is the last time that this program is used because this teacher wants to focus more on sight words and will look for a reading program to do this. She also wants to come up with a set of sight words from his Bliss Book. At this same time Heather says she doesn't want to work with Walter out of a classroom

context. She says the computer is a tool not a subject and she will work with him alone only if it is requested by another teacher. (important).

(I) My interpretation of Heather's comment is that this is because she wants to keep things as integrated as possible with Walter. Thus she only wants to be doing things during her time with Walter that coordinate with what the other people who are working with him are doing.

(T) The switch to a new program was made the following week on February 25th by using the Kidwriter program. This program allows the student to choose from a set of 100 pictures, numbers and letters of the alphabet onto the screen. His first task is to put all the members of his family onto the screen. (O) He chose a girl for himself and then says that he's not a girl when asked that question. (T) The teacher then picks the letter "B" and asks him to put something that starts with it onto the screen. (O) He chose a barn and made it an orange color.

(O) My observations at the end of February as I stopped to reflect on the events of the past while, are highlighted by the following:

- the focus is shifting since the Feb 13th meeting in that Heather seems to have redefined her goals and a redefinition of overall goals for Walter.
- the focus for Walter has become that of assisting him with sight vocabulary based on the words from his Bliss Book.
- the computer is being used as a tool (rather than a subject) for Walter's communication needs.

(XV) This idea is also cross-validated with the ideas of the computer being used as a tool for assessment of learning using the various programs of First Letter Fun and Wordburner.

(N) After a school break things recommenced on March 11th. My schedule changed somewhat as I would no longer be spending time with Heather on Fridays but would be spending time with Walter during a class

period on Mondays and Wednesdays. (T) On March 11th I commenced in the new class where Walter would be spending time using a program called Aquarium. There are a choice of six possible activities. The initial focus chosen by that classroom teacher is the activity where the student has to set up the screen like an aquarium. This activity used the AFC (Unicorn) keyboard with one letter cues for each of the possible choices to be made within this activity. (For example F-food, R-remove, S-stop, A-add, Z- Zebra fish...)

(R) An observation from the classroom teacher says she hopes this program can provide a bit of assessment for Walter's reading as she thinks he has a vocabulary of 92 words. Her goal is to possibly give him something that will occupy him later on. She also says that he is "not a mathematician" as she has tried to work on numbers with him with little success.

(T) Following this class, I went to the regular class I had been with on Mondays since the beginning of the year. Walter continued to use Kidwriter with the AFC board and the teacher giving him direct commands to put 3 things on the screen, that are in his bedroom. (O) He chose a chair and then there was some confusion again as he picked a girl for both himself and his father. He also chose a girl and put it beside the letter "B" that the teacher has asked him to match. Maybe there is some confusion between the letters "B" and "G".

(I) My interpretation of this session was that even though it was quite structured, Walter seemed to make no complaints about it being this way which was somewhat unusual because he normally complains. This idea can be cross-validated with the prescription made on February 13th, at the staff meeting, that Walter seems to need structure. (Even though most of the time Walter rebels against structure, if he is forced to use a program he doesn't like.)

(T) That same week I also went to the Wednesday class, on March 13th, where I was working with the Aquarium program. The classroom teacher gives Walter a direct command to see if he can follow it and as a test for his reading (that is his reading of the keys on the Unicorn keyboard). (O) There seems to be some problem with the accessing; as the area that Walter can press is only one inch square and sometimes his hand will slip onto the next letter as they are very close together.

Please see Appendix D for further discussion of the problems arising during this time period.

(O) On March 18th, the day after St. Patrick's Day, Walter came in with a St. Patrick's Day balloon and initially his attention was focused on playing with this. We used the Aquarium program, and I was the only person conducting the class period, a change from previous sessions in which the teacher was present the whole time. The accessing continued to be somewhat difficult as I had to move the board so Walter can press certain keys that are on the far right or left of the AFC board. Walter seems to like the interaction part of the class and I continue to dialogue with him and occasionally ask him to add something specific. During this session Walter seemed to be distracted at times by a real Aquarium that was placed beside him.

(I) Both my and other peoples' interpretations that he really seems to know where the appropriate keys are on the AFC board. (Q) The question is whether he is reading them or has he memorized them at this point?

(T) Also on the same Monday I worked again with the regular classroom teacher (Dana), who I had been with since the beginning of the

year. That day she switched to using Kidwriter because it works on whole words and single letters.

(P) The teacher working in this class made a prescription to use Kidwriter because the letters are much bigger and this may be easier for Walter's vision. An observation by this teacher is that she felt that the Reader Rabbit program was getting boring for Walter, (although this was not directly asked of him).

(O) During the class Walter worked on Kidwriter. The teacher had put the word Walter on the screen and asked him to find a picture of himself. He chose a girl and he responded to questions, that the picture of a girl is not a girl and that he is not a girl. He appears to again like the interaction. He also doesn't know what starts with the letter "C" and confuses "C" & "D", and thinks that "G" & "D" are the same as "C".

(T) In mid-March (March 20th) I talked with Walter's Augmentative Communication teacher from the previous year to find out about a program called Bliss Apple, which Walter had tried but didn't like (according to this teacher). The purpose of using the program was to assist Walter with communication of his needs. (R) It is a single switch program and Walter was not motivated by this because he wanted to use the keyboard. The way the program works is that a reference chart, made distinct for each individual, gives the corresponding numbers for the Bliss symbols. Then on the bottom of the screen are the numbers 0 - 9 and the punctuation marks. These are scanned with an arrow and the student must hit the single switch when he/she wants to choose that number. Then when the full reference code has been chosen the corresponding Bliss symbol and word are placed on the top portion of the screen.

(O) On the last Monday of March (March 25th) when we normally do the Aquarium program we couldn't find the clear plastic AFC array and so we didn't do anything. In the following class we noticed that Walter didn't have his splint on which made accessing difficult. (When this occurs and we attempt to put his splint on he refuses and will contract his arm so that it is impossible to put it on. So then sometimes we proceed without it, although the procedure is to call a representative person (aide) from residence to put it on.)

(I) My interpretation of why he doesn't like his splint on is because he is not like most of the other students who don't wear splints, and also he may find it restricting and uncomfortable.

(T) The task for Walter was, using Kidwriter, to put on the screen all the things he'll see when he goes to Parc Safari in May. Walter picked a bus and changed the colors of it. Then the teacher picked a dog and put it on the screen and he put up two girls. He picks the letter "C" then "D" as the first letter for the dog. When the teacher tried to do some things Walter complained by putting his hand on hers to try and push it away. Walter has a new tray with his Bliss book mounted on a triangular block that is velcroed to the tray.

(P) The teacher prescribed that she wanted to do more of what she was doing today with Kidwriter as this is a flexible piece of software that can be used for first-letter matching and can be contextual for Walter.

(O) In the beginning of April after an Easter break, (April 8th) it took some time to find the Aquarium plastic AFC array. When we did begin I had to constantly move the AFC board around to suit Walter's reaching

ability. I asked Walter if he knew why he was using the splint. He said yes and also yes to the question that it helps him to use his splint.

(T) In the class following this one on the same day, we again worked with Kidwriter. The teacher was working on the words CAT and DOG, wanting Walter to find the corresponding pictures. Walter chose a dog for the cat and chose the letter "A" for the first letter of the word CAT. This teacher wants Walter to learn the first letters so that he could point to these on a sheet if he had to communicate with someone who didn't know Bliss. Despite Walter's confusion about the first letters of words earlier on in the class, when visually given a choice Walter seems to know some first letters. Walter seems to be having some difficulty with accessing as the board needs to be moved so he can reach certain squares and his hand gets caught on the right hand of the keyboard.

(Q) My observations cause me to wonder at this time whether Walter knows what is meant by the "first letter" and if this idea of a first letter is related to the number concept because we are dealing with the idea of "first" (Walter seems to have difficulty with number concepts). In recognizing a letter Walter has to understand the sound/symbol association and is Walter able to do this? Is he already doing this?

(O) The next time we used the Aquarium program (April 11th) with the AFC board we had difficulty getting set up because Walter couldn't see the screen very well and again his hand slips and doesn't press the letter he wants. He has found the letter "S" which stops the activity and brings up the menu of six activities. He pressed stop several times when I ask him if he can add something. He likes to do this and laughs when he presses this. Today, when I give Walter a direct command he doesn't want to do it and focuses his attention on trying to grab my pen which I am writing with, on

the left side of him. I asked him if it was my pen he wanted and he said "yes". He then held this in his left hand and drew a few lines.

(I) My interpretation of Walter trying to press the letter "S" to stop the program is that perhaps this offers him a sense of control and empowerment which he seems to enjoy. (XV) This cross-validates with many things other teachers and people who work with him have said that he likes and needs to have the experience of control.

(P) After seeing that Walter really liked using the pen I would make a prescription to give Walter a chance to use a writing device such as crayons or colored pencils. This may provide tactile involvement in which he is very motivated.

(T) The teacher who conducts this class, but who does not directly participate in the sessions with Walter, feels that maybe the whole word approach is better because it is more congruent with reading Bliss - which just has one symbol for each concept (ideograph) which Walter reads. Perhaps phonics may be confusing. She suggests showing him a card with the command that one would like him to do in the Aquarium activity. This way he would have to read the card and choose the corresponding first letter on the keyboard. This teacher also says that

it is hard to have concrete goals for Walter because it is hard to know concretely what he knows.

(O) The week after, on April 15th, when this program was used, I asked him to add his choice and he added some of the things I suggested but was distracted by a student sitting next to him and also by the teacher. Again he sometimes presses the letter "S" for stop and this time it was when he was trying to add something, (the letters "S" and the letters "A" are side by side, with the letter "S" being on the left). Perhaps he needs a keyguard or a larger letter keyboard.

(I) My interpretation of what I saw was that it seems that when he is distracted it is by the voices of people nearby or that he wants to see what type of program the other students are using.

(T) Also on the same day during the next class, Heather wanted to try a new version of LOGOwriter with an Alphabet scan using large letters. The letters appear in the same space at a preset speed until the spacebar is pressed when a letter is to be chosen. The "up arrow" key on the keyboard will restart the scanning in the next space. (O) Walter seemed to be concentrating immensely, as he tried this briefly after a demonstration from Heather.

(R) The teacher that I have been working with on Kidwriter, commented as we observed this, that <u>still</u> no one is looking at the whole person (regarding Walter). Therefore it is not known whether what is being done by each teacher is complementary to the other teachers' efforts. Important!!. And she thought that the Augmentative Communication person was working with him on reading. (T) Heather says that she wants to assess what are appropriate sight words. (Q) She asks what is the point of doing first letters?

(O) The following day, April 16th, when Walter and I normally work on the Aquarium program, I came into the classroom Walter was sitting sideways with his left hand trying to use the keyboard. (R) (Heather has stated that he likes tactile involvement and perhaps this is why he tries to use the keyboard so often). (O) He helped me setup the Aquarium program by pressing the spacebar and the control keys. He wanted to try one of the other programs called "fishing" in which he needs only to press the letters "U and "D" on the keyboard to lower and raise the fishing rod and also the spacebar. He presses the spacebar and the letter "D" and seems to enjoy this program but then wants to play the Aquarium.

(T) The next week, April 22, he still wants to use the keyboard but I set up the AFC board and he then faces straight on. I tried to have him read commands off a board and he seems to know the words ADD and STOP. (O) He also wanted to grab my pen again as he did on April 11th, and also use the keyboard. He seems to be very co-operative lately since it is Spring (his current Augmentative Communication teacher said that he usually does well in the spring.)

(T) Also on April 22nd, a new program was tried called "Wordburner" which is part of the ABC Dragon series of programs by the University of Washington. This class is being conducted by Heather and the other classroom teacher. It is a single switch program that has been set up with words that are familiar to him from his Bliss book. The program has the capability of storing twenty sets of 4 words each. There are also a variety of excercises that can be done with these words. This day we try the version where the teacher gives Walter the word orally and then Walter has to visually choose the word from a list of four on the screen. An arrow points to each word one at a time and Walter has to hit the single switch when the word on the screen matches the word he has heard. The teacher puts each word into context by putting it into a sentence. The words are shown more than once and are in a different order so that Walter won't be able to memorize where a word is on the screen. A report can be printed out at the end of each session that shows a summary of the number of tries done for each word in the session.

(I) I interpret that this program could be very helpful in assessing what Walter knows and in charting his progress.

(R) Heather and the classroom teacher are very encouraged by what they have observed here today and Heather says that what has occurred here

are behaviors that are not measurable by numbers but recordable through written observations. They concluded that Walter can see the screen, scan what's on the screen and plan when he will hit the single switch. In other words, he gets ready and concentrates on what he has to do..

(T) After this first day some of the words on the word list will be removed. Those that are not some of Walter's more common words will be removed in favor of words that are more contextual to Walter.

(O) On April 22nd and 29th, when Walter used the Aquarium program he helped use the keyboard to set up and also continually tried to grab my pen. He seems to really feel a sense of accomplishment when he does this. One day when he grabbed my pen, he was drawing with my pen on my piece of paper and he responded "yes" when I asked him if he wants to draw. I made some flashcards with the commands for the Aquarium program. Walter seems to be able to add food, remove Angel fish and add a baby guppy. When given his choice he adds many things and presses stop. Heather had set up the Wordburner program for the Aquarium words but then decided that it would be overkill to be doing this program twice.

(I) My interpretation of using the flashcards is that this is a good idea because there is less chance of the student getting distracted by other words on the sheet of paper.

(I) My interpretation, of seeing Walter grabbing and trying to draw with a pen, is that he has a desire for tactile involvement and has seen others using a pen or pencil to draw. He is often motivated by trying to do what he sees others doing.

(P) I would prescribe that those working with Walter could give him this opportunity to do tactile exercises. This could perhaps increase his tactile dexterity and confidence in this area.

(T) On April 29, we had our second day of (oral matching) using the Wordburner program that had been slightly modified with some new

contextual words. The classroom teacher continued to put the words into a context and this provided some constant interaction. (O) In using this program Walter had some difficulty with the words bus, sister, food, baby, home, boy, and car (in each of these it took him 4 or more tries to get the correct answer). (T) We also tried another form of the program which gives the student the word visually on the left hand of the screen and they have to find the match for it amongst the four words shown on the right hand of the screen. The words shown on the right side are mixed up spellings of the word on the left - i.e. bed on the left and deb, bed, dbe, & bde on the right.

(I) My interpretation that took place during this session is that when the teacher needed to go and talk to someone, while Walter was still using this program, he became very distracted and took a long time to find the word he was requested to find. Thus depicting a preference, for dependence on, the teacher's interaction. (IMPORTANT).

(XV) This can be cross validated with other peoples' observation that Walter likes interaction and relies on it. It appears to motivate him.

(O) On May 6, the first session continued with the usual Aquarium program and Walter helping to set up by pressing a number on the keyboard to select a number of plants. But he indicated, when asked, that he wanted to be able to set up by himself. Walter appeared to be crying or grimacing and then I noticed that he didn't have his splint on but he would not let me put it on either. Walter continued to try the keyboard and the grimacing stopped as he added a few things to the screen when shown one of the cue cards. He appeared to be reading the cue card fairly accurately as he knew the word baby but not guppy.

(T) In the next class, May 13th, the Wordburner program was worked on, doing the visual matching. The teacher began by saying that we're going

to aim for the music and flashing which means that Walter would have to get all four correct words in one set (in order to get the music and flashing). (O) Again, the teacher left this class for awhile and Walter wanted her to be beside him so he could interact with her and receive her feedback while he was doing things. There were some minor problems because some of the words were too long for the screen and not accurately shown. No accurate results of this session were taken because of the screen problems. The last part of this class was done doing a visual matching of the single alphabet letters and this was Walter's choice because he didn't want to do anything else that the teacher offered him.

(O) Also on May 13th, in using the Aquarium program we had a few problems setting up because of a bilingual switch that was hindering progress. It took up about half of the class time to identify and correct this and it was concluded that the AFC keyboard wasn't working. So using the keyboard Walter added several things on his own initiative and seems to want to use the "remove" (which is the letter "R") key now. Walter had some difficulty using the keyboard and responded "yes" when I asked him if he needed my help.

(R) Before this class, on May 13th, this teacher said to me that she didn't really think the Wordburner program was doing any good and that it was not helping him learn or helping to assess what he knows. (O) I think Dana was frustrated because it was a slow, indirect process. (T) Anyway, we did the Wordburner program and started off with the visual matching section in which it took Walter more than 2 turns to match the words mother, home and father. Then we did the oral matching which we didn't have time to finish and unofficially (according to my observations and not

the results printed by the program) it took Walter more that two turns to find the words baby, drive and mother. (O) Again it appears that Walter likes the interaction with others and looked to the teacher and myself for approval. Sometimes by the time Walter wants to hit the switch the arrow has passed the word that he wants.

(P) A prescription by one of the teachers at the conclusion of this session by saying that doing the oral matching is better because the visual matching is not using his strength and some words are hard to read.

(T) The following week, May 15th, I worked with Walter by myself one day and we could not get the Aquarium program and Walter requested doing the Farm program but we couldn't find it. Note: software is kept in each classroom and is used by others when we're not there. So, we did Reader Rabbit using the keyboard. (O) And he wanted to use the keyboard and pressed the correct key so that he could get the matching pictures to words. He found out how to change the screen and did this and laughed. He was using his left hand with no splint on and had good control. He would grimace if I attempted to press the keyboard.

(T) On May 22nd I couldn't get the AFC board working (this is not a usual occurrence) so Walter ended up using the keyboard with the Aquarium program. I put tape on the corresponding keys that he could use for this program and he had a bit of trouble at first but when he got going he added tons of angel fish and other types of fish and food. (O) He changed programs and got the fishing program using the "U" and "D" keys but needs to watch the screen more accurately in order to see when his fishing line has

caught a fish. Using tape on the keys did help to identify those keys that he needed to use and in turn helped Walter.

The next session on May 27th was using the Aquarium program - using the keyboard since the AFC board was still not working. (O) Walter used his thumb on his left hand. Walter added a few things to the aquarium and then pressed stop and wanted to play other games. He was able to press the Y & N keys and 1 & 2 keys. He then flip-flopped back and forth between the fishing, aquarium and other games. It appears that Walter seems to know the letters S, A, F, U, and D as he presses these on the keyboard when required to in doing the Aquarium & Fishing programs. The teacher in this class says she wants to try another program called Odell Lake.

(T) On May 27th the Wordburner program was done again and this time the teacher had in mind to see how many words he knows. The teacher reminds Walter to look at the screen because he is always looking away. Sometimes Walter has trouble hitting the key because his movements are slower than the pace of the arrow. (O) The oral matching was done and the following words Walter took three or more tries - bus, sister, school, sleep, eat and bed.

(R) This teacher summarized by saying that Walter will probably not use the computer for communication but it is a good tool for assessment for learning and teaching (but learning and teaching are our desires and he stated that recreation is his desire). Also, referring to the transfer of skills from using the computer i.e. It does not occur to Walter to use the computer as a communication tool. Perhaps at this stage his computer skills are not good enough to make it a worthwhile tool.

(XV) This is a cross-validation of what I observed when using the program First Letter Fun, that it could be used for assessment of learning certain reading skills.

(N) On June 3rd, the Odell Lake program was tried and Walter wanted to use the keyboard. He didn't appear to understand what was really happening in the program. (This program presents the ecology of the lake and the student chooses the type of fish he/she wants to be and then has to survive in the lake by eating appropriate food and escaping from predators. This requires a fair bit of prior knowledge of this environment). (O) I helped Walter only when he agreed to it because he often rejects being helped. One thing that was truly clear was the Walter seemed to be reading when the screen said to "press spacebar" and he would do this without any prompting. (IMPORTANT)

(N) To begin the month of June the teacher doesn't want to do the Wordburner program any more because the reports of Walter's school year are done and this gives him a chance to do something of his choice.

(R) This teacher reports that word recognition skills were worked on using the Unicorn keyboard with Kidwriter. Several methods were tried to see what words he could read including Wordburner with single switch access and words he did or should know. He recognized about 25% on the first try, the most of which were the words: mother, father, sister, baby.

(T) During this class Walter gets his choice and he chooses to do the First Letter Fun - Farm program. He is using the keyboard mostly the spacebar and we press the return key for him. (O) He does the circus, park and farm sections. At times he presses any key and the teacher says he is just joking with us to see what our reactions will be. Also the teacher assists Walter by giving him another word that he knows, that starts with the same letter.

(O) In the next week on June 10th, Walter didn't remember doing the Odell Lake program and so we did the Aquarium program on two more occasions. He wanted the play the other games that are part of this software but he became distracted both times by what others are doing.

(I) My interpretations of this session are that he seems to like to do the fishing program but it may be hard for him at times to see the things on the screen even though he says he can see colors. He seems to be using the keyboard accurately and likes to try a variety of games.

(XV) This is a cross-validation of others observations that it may be hard for Walter to see the screen depending upon what is on it.

(T) On June 10th, Walter went straight into the class and sat beside the Apple IIe and started pressing the keys. He chose to do the First Letter Fun - Farm and again the teacher and myself pressed the return key while Walter pressed the space bar. Also the teacher gave him other words that started with the first letter that he was looking for at the that present time, to assist him in identifying what was required. (O) Walter kept looking away from the screen when he was not pressing the spacebar so this must have made it hard for him to keep track of what was going on and have good timing.

(N) On June 12th, this was the last computer class that Walter had and a representative from Logo C.S. Inc. came in to be with Heather to review and evaluate a piece of software that was tried a little while previously. (T)This time a single switch was used instead of the keyboard. This is a program that scrolls through the letters of the alphabet and requires that the student press the single switch in order to choose a letter then the scrolling continues in the adjacent space starting with the next letter. (O) Walter responded that he can see the letters on the screen but that he does not know the alphabet. The initial speed is too fast for him but also it requires Walter

to have a lot of patience in waiting for the letter he wants as the whole alphabet must be scrolled through. This then becomes an amusement for him as he fills up the screen with the letters K, L, M, and O. Walter states that this is not really fun to do.

(Q) Both my and the teachers' interpretations include the question that if the letters changed faster would it keep his attention? (P) This session is concluded by the representative and teacher suggesting improvements to make this more fun, such as: having options at the bottom of the screen with a scanning mechanism that changes the colors etc... (Q) I have a question as to whether the initial speed is adjustable? (P) And if so I prescribe that if be changed to match Walter's needs.

MAIN EVENTS AND THEIR IMPLICATIONS

The following are main or crucial events that took place during the course of the nine months, the causes and effects of them and their implications for other students and or the software involved. If "**" follows a word then the definition of that word can be found in the Glossary.

1. The first main event occurred while using the program Davey's Digits. It was realized, by those involved, how much was unknown about Walter. The teachers realized that they didn't know anything about Walter's knowledge of numbers and there was nothing in his Bliss symbol book about numbers either in numerical or word format. This is mainly caused by there being very few accurate and appropriate assessment methods for students with cerebral palsy and it was questioned whether anyone had ever assessed numbers with Walter. This program in some ways acted as an assessment tool or a tool to bring about further realizations. It showed that Walter knew the numbers 1 & 3 and quite often mixes up the numbers 2 & 5. The implications of using this software are that it could in some ways be used as an assessment tool for assessing a student's knowledge of numbers.

2. The experimental use of the IBM speechviewer software gave Walter the experience of controlling something with his voice thus increasing motivation. He was also able to hear his voice played back which was probably a first time experience. Even though this was not used any

further with Walter the brief experience supports the idea that it probably would have good outcomes for other non-verbal students to experience control by using their voice and also experience hearing what their voice sounds like.

3. When a significant event in Walter's family life happened it had strong consequences for the way he functioned in the class. (Which seems a fairly natural human response). An annual slump at this time of year combined with the event of his baby brother being born, caused Walter's behavior to change. He needed to communicate this to every one he talked to. It caused him a lot of distraction and he exhibited extreme reactions of refusing to do many of the things the teachers asked him to do. This caused confusion for the teachers and caused them to ask themselves "what are we doing with Walter?". The implications of this event, are for those working with students to keep aware of their communication needs at the beginning of each session. This event also caused people to question what was being done with Walter, and what would happen if he doesn't want to use the computer any more (especially during the regular class time) and what does this imply for his future in and out of the classroom.

4. A positioning session was held as a result of trying to figure out what are optimal ways for Walter to use the computer in order to enhance his accessing and vision. An interdisciplinary team took part in this session. The factors that triggered this session were a lack of ideas as to what to do with Walter that is best physiologically, as he often wants to sit sideways and often doesn't have his splint on causing difficulty in hitting the appropriate

keys. The results of this session were for Walter to sit straight on at the computer because it was best physiologically and also to have a computer table that has a separate table for the monitor and to use the APPLE IIGS with the detachable keyboard.

5. By late November Walter was showing a lot of assertiveness and going directly to the computer and waiting to use it. This seemed to motivate Walter a lot and is a non-verbal sign of Walter' attitude. The cause of this is that since Walter can drive an electric wheelchair he can express himself in physical movements. For non-verbal students driving an electrical wheelchair can provide them with another form of expression of their ideas, desires and spatial skills. This can be seen at student dances where students can independently dance (by moving their electric wheelchairs).

6. The issue of 'accessing'** is very important and is always an influential point in the process. Heather says that accessing varies with the task and is a big part of the process. The effect accessing the computer has with physically handicapped students is great, because if access is not sufficiently well set up then the efficiency of the session is reduced. A lot of planning and modifications need to be done. This has implications for all students because accessing has to be looked at carefully and adjusted to suit each student. Also, when viewing software one must look at what is involved in the accessing part of it and what are the accessing possibilities of the students involved. These then need to be co-ordinated.

7. In late December 1990, a new page was put in Walter's Bliss Symbol book with the names of all the games that Walter can play. (There was no particular order). This is in relation to the reading goals that they have for Walter and it is contextually based. As a result of learning the words of all the games and Walter's desire to make his own choices, this page was put in his book. The effect of doing this is to enable him to communicate and control what he wants to do through his communication. By doing this one is not limiting the students' attempts to communicate and control. The implications for others are that one should give them effective communications tools i.e. to give them all the vocabulary they will need to communicate in all circumstances of their daily lives. Whether this be through the use of Bliss symbols in a display or book, or in any electronic communication device.

8. In January the APO Quebec conference was held and Walter's teachers were attending and decided to feature Walter's computer use over the past three years. The main focus of this was "accessing" and several conclusions were reached among the three people and in turn these conclusions will effect their future decisions.

- Communications is a critical issue and an interdisciplinary approach is necessary because there are so many facets that are necessary to be understood in order to understand the whole picture of a student with cerebral palsy.

- In the last three years they have gone full circle with types of accessing. They started using the Unicorn keyboard, then used varieties of

single switches, the regular keyboard and now have returned to the Unicorn keyboard because of its flexibililty.

- There is a concern for what will be available in Walter's future for computer use and if what is done now will be suitable to the needs of his future life circumstances.

One of the methodological implications arises from the fact that exploration takes a long time and sometimes they have to go a full circle of exploration, as they had to do with accessing.

9. The program Reader Rabbit was used to assess and aid in the learning process of Walter's reading of words. One noticeable aspect of this process was in the visual matching game. Walter seems to have a strategy for playing this - he turns over the last one he has just seen and then progresses to choosing another one. He does this in both the picture-to-picture and the picture-to-word categories. The main implication of this may be that this software can be used to determine a student's learning strategy. Heather stated that as a tool the computer is very useful because it offers a wide variety of experiences and people get to observe him having these experiences.

10. A crucial issue in any session with a non-verbal student is communication. One thing that occurs is that when Walter is using the computer, his Bliss Symbol book is taken away so that he can properly access the keyboard or the Unicorn keyboard. This restricts him to be able to respond only to yes/no questions. Thereby having the effect of limiting what he can say and giving others the control of the situation. Hence, he

may not be communicating as much as he would like to. There is a need to place his Bliss book within reaching distance so that he could at least indicate that he would like to use it. The implications of this are that this may be the case for all students who are Bliss users and are using the computer. The exception to this is if the students are using the computer as a Bliss type communication tool. One idea would be to have the Bliss symbols immediately available on the computer screen.

11. In early February there was a staff meeting initiated by Heather. All the people that worked with Walter, in any capacity, were there. The cause or concern motivating this meeting was her confusion as to what her goals were in working with Walter. This partly stemmed from the lack of communication and (possibly a lack of vision as to what a full life could be for such a person) among the people who worked with Walter. The results of the meeting were that - 1) most of the confusion was caused by no one person being in charge or co-ordinating Walter's learning activities. 2) The IPP (Individual Pupil Plan) is the guide for the goals that are followed throughout the year. 3) It is necessary for Walter to wear a splint and there is now a process to ensure that he gets it on and finally, 4) it was agreed that the computer would be viewed as a tool and not a subject for Walter.

The implications of this meeting that have direct consequences for the Mackay Center are:

1) that the problems for such learners in this environment were made specific by having the formal meeting, 2) Heather decided not to experiment with Walter unless it is in co-ordination with the classroom context. This is critical since Heather is the computer expert and the desire is to use the

computer as a tool in coordination with the other teachers and, 3) the focus in English words has shifted to "sight words"** because in considering Walter's future there is possibly a serious need for whole words especially if he's in an environment where no one knows Bliss.

12. In late March the focus in software switched to using software that was focused on whole words instead of phonics. The reason for this was that one of the teachers didn't think it was necessarily helpful in doing sight words to continue to focus on first letters only. The effect of this decision was to start to use the program Kidwriter which offers the possibility to have either single letters or whole words and pictures. Also the letters are quite large and their size can be changed which may be good for Walter's vision. The implications of this are that the use of the program Kidwriter may be a good piece of software to use in a student's learning process of reading words and also using first letters.

13. One of the circumstances of accessing using a Unicorn keyboard is that this board often has to be moved accordingly so that Walter can access the different squares on the board. The board has to be moved to suit the span of the student's movement based on their physiology. The number of squares is based on the requirements of the software. If the placement of the squares is done well then accessing can be made simpler. The implications of this is that if one wants to ensure good accessing then the software needs to be screened before hand to see what type of input is needed and how this can be transferred to the Unicorn keyboard so as to match the range of movement the student has.

14. Often what Walter is doing is isolated from what the rest of a class will be doing. Walter will get distracted by loud voices or by his curiosity thus causing him to lose track of the task at hand. The implications of this are that who ever is working with Walter on this needs to be aware of when Walter is likely to get distracted and try to remove the distractions, or bring him back to task by moving his location in the classroom.

15. Walter had a desire for social control and in the use of the program Aquarium, he would press the "S" square to stop the program and this would require someone to start it again. The implications of this are that Walter can have control over other people and enjoys it. Maybe other students who use this software can experiment with the same things and will find facets of the program on their own that motivate them or give them a sense of control that they hadn't otherwise experienced. Again the computer is being used as a tool that could show facets and skills of the students and let them experiment and discover things for themselves.

16. In April, one of the teachers comments that she feels that no ore is looking at the whole person of Walter. This came about while looking at some new software with Heather and a representative from LOGO C.S.Inc. We were looking at the aspect of reading with him and one teacher commented that still many people were looking at the aspect of reading with him. This may be causing fragmentation with different people looking at different aspects of Walter. One person thinks that the other person is looking at something and their is no continuity of communication of these

facts. This has implications for all physically challenged students who may have many people working with them from different departments in their education program.

17. Something that was discovered was Walter's desire for tactile involvement as shown by several examples of Walter wanting to use the keyboard and grab my pen. Walter initiated these interactions and perhaps this gives him the tactile feeling he wants and may have lacked through his earlier development. In most cerebral palsy students there is a lack of experience with manipulation of objects. The implications of this could be useful for all cerebral palsy students as the use of a keyboard provides a tactile type of experience which could be beneficial. Also a prescription might be to give these students the chance to color using crayons or colored pencils. (Note: The use of a mouse has not been tried as it would require fine motor and visual coordination that may be difficult for Walter.)

18. The program Wordburner was chosen to teach reading of common words to Walter. These are "contextual"** words taken from his Bliss Symbol book. This software uses the skills of scanning, planning and getting ready and hitting the switch. Walter showed that he could do this even though when other people didn't think that he was able to scan. The reason this program was chosen was because it was a better transition from his previous knowledge of Bliss symbols. The implications from our observations and his use of this program are that it can definitely show more about the student's skills of scanning, planning etc. Also it can be used as a

learning and assessment tool for whole words since it provides its own compilation of results. ** See the word definition list.

19. Walter's use of the keyboard has indirectly demonstrated that he is learning letters - One could see that in using the keyboard Walter knows the letters S, F, U, A, D and the spacebar. (This was found while using the Aquarium and Fishing programs). The implications of this program are that it can be used for assessing a student's ability to recognize certain letters on a keyboard. The accessing of the keyboard must be set up efficiently if this assessment is to be done well.

20. The interaction, that takes place while using the computer, with the teacher was very crucial to the effectiveness of the session. Walter relies a lot on the teacher for prompting, approval and recognition of what he's doing. This was most apparent when doing the Wordburner program. When the teacher had to temporarily leave the session Walter kept looking for this teacher and it took him a very long time to find where he was supposed to look in the program. The implications for others who use this program are: this program requires aural input and the student may become very dependent on this. Hence, the dependence on the interaction that builds up may become necessary for a successful learning situation.

21. Something that is quite contrasting to Walter's like of prompting and interaction, is that during any session if anyone interferes with what he is doing on the keyboard he will grimace. This is indicating that he does not want anyone to interfere with what he is doing. What causes this, as it

appears, is his desire to control what he is doing. The effect of not obliging with Walter's need for non-interference, results in frustration for Walter & a lack of motivation. The implications of this is that the non-verbal communication of a student must be given attention to or, the affective aspect (motivation, frustration) of the session will be diminished, lessening the overall learning effect.

22. One of Walter's teachers concluded that after using the program Wordburner, that Walter can recognize about 25% of the words on his first try. The implications of this are that this piece of software program could be a good assessment tool, and has sufficient flexibility for word input to be appropriate for the individuals' "context" (this is very important).

23. The spastic movements sometimes cause a disruption in Walter's timing in accessing the program. A spastic movement may cause him to look away from the screen at an inappropriate time and miss hitting the switch. This will affect the assessment of a task that Walter is doing. This happens in such a way that it may appear that he doesn't know something when in fact he does and the spastic movement has caused him to miss the desired key or timing of the switch. The implications of this are that this could be happening to any cerebral palsy student and they will need to be brought back to task and this needs to be included in the assessing the accessing and adequacy of a piece of software.

TRANSITION NOTE

Up to this point in this thesis, the history of descriptive observations and interpretations has been told, followed by an account of the main events during this time and their interpretations. This is now followed by documentation that shows the relationships among the events that make up this environment and the relationships of the categories in this environment.

The conclusions, further research questions and recommendations follow. These are derived from the information gathered in the previous sections and the appendices of this thesis.

FIGURE 3

LARGER RELATIONSHIPS IN THE OVERALL EDUCATIONAL PROCESS OF WALTER

Communication among people who work with Walter
(good communication will reduce fragmentation for Walter and facilitate consistency of goals and vice versa)
i.e. bad communication will increase fragmentation and lessen the consistency of the goals

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|

Establishment of the goals and aspirations for Walter from those who work with him.
(if communication is lacking, then the goals become unclear and Walter becomes fragmented in his learning. The teachers then become frustrated in knowing what to do because they may not know whether what they're doing compliments what someone else is doing)

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The choice of goals affect what is worked on at the computer i.e. if the choice of goal for academic skills is reading. Hence the approach to be taken for this goal of reading needs to take into consideration what his life circumstances are at present and what the future holds for him in the way of computer choices.

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The academic skills are chosen (reading) but Walter has a desire to play recreational games - this he stated in September 1990. He has been doing this on the computer in residence and during his Wednesday afternoon recreational time.

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Software is chosen that matches the academic skills that are in mind. For example (Reader Rabbit, Kidwriter, Aquarium & Wordburner for reading skills)

Walter's physical and physiological circumstances affect the development and, type of accessing, also the positioning at the computer. Set up Unicorn keyboard and observe to see if it is a good setup and whether Walter can reach all points on the keyboard.

Develop or adapt accessing for the software chosen and Walter's needs.

Use software to assess what he knows and is learning. And possibly what are his learning strategies.

(if this is done well then new goals can be established, and if not then it will remain unclear as to what Walter knows and what are appropriate goals for him)

Reassess goals and start over (top of page 73)

FIGURE 4
THE OVERALL PROCESS IS AFFECTED BY THE ACTUAL SESSIONS WITH WALTER
WHICH CONSIST OF THE FOLLOWING RELATIONSHIPS

'The teachers' goals for the session which need to be interdependent upon communication with other teachers and specialists who work with Walter

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Walter's life circumstances will hopefully be conveyed by his communication at the beginning and throughout the session

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Communication with Walter - he may want to do something specific or communicate something specific and if this is not taken into consideration then his motivation may drop.
Also, as teachers want to do certain things it is important to ensure that Walter knows and understands this. i.e. establish clear communication as this session begins.

(This is really important. If this is not effective then both parties may become frustrated and this can negatively affect the success of assessment, learning and motivation)

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The environment of the classroom where the session is taking place needs to be considered.

(Distractions sometimes cause Walter to loose his concentration and motivation)

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The hardware and position at the computer need to be considered. Presently an Apple IIgs was set up at a special table where the screen was on a separate table above the keyboard. This was used during Heather's sessions on Friday and it was hoped that it would assist with his vision because it was adjustable.

Accessing to and during the program.
(This definitely affects Walter's level of frustration and success with the program. Sometimes one has to move the wedge, that the Unicorn board is on, to suit Walter's movements because it may require that Walter reach areas he can't)

The software and the timing in the program. The timing in the program affects Walter's ability to feel he has control. If the timing is inappropriate it needs to be adjusted. Also, there is verbal and visual prompting by the teacher to Walter that takes place depending on the software. This is done to give an introduction to the program and it also provides interaction during the program and Walter seems to rely on this.

Learning and assessment that takes place. This needs to be observed and measured by those involved. This is somewhat sketchy now as to how this is even done - or if it is formally done.

This in turn affects the teacher's goals for Walter (Step 1 page 75).

CATEGORIES IN TABLE 1

The following is a list of the categories that will be shown in Table 1 and their corresponding number that is used in the chart:

Category Name	Corresponding Number
Software	1
Hardware	2
Accessing	3
Assessment	4
Academic Skills	5
Learning & Measurement	6
Verbal Input	7
Teacher's Goals	8
Concentration & Motivation	9
Control & Choice	10
Communication between People	11
Student's Life	12
Student's Physiology	13
Classroom Environment	14

These numbers are used in both the horizontal heading row and the vertical column and in both instances refer to the same categories. In the Directed Graph Matrix shown on the next page, both sides of the diagonal are not needed because they would be showing the same information. In other words all the types of relationships among the categories are shown in the right hand side of the diagonal.

DIRECTED GRAPH MATRIX

TABLE 1- Showing the relationships of the categories within this Educational Environment

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	V	C	C	C	C	A+-	A	C	D	E	D	C	E	-
2		V	C	-	-	-	-	C	E	E	-	-	E	B
3			V	-	-	-	-	F	-	D	B+-	-	D	-
4				V	C	C	-	E	B+-	-	B+-	-	-	-
5					V	C	-	B	-	-	-	-	-	-
6						V	B+-	F	B+-	F	B+-	D	-	-
7							V	B+-	E	-	-	-	-	-
8								V	D	C	F	D	-	-
9									V	D	D	B+-	-	B+-
10										V	D	D	F	B+-
11											V	D	-	D
12												V	F	-
13													V	-
14														V

Key of the symbols in this chart-

V = the variable
A = what is chosen in the left category column will influence the outcome of the vertical column
B = what is chosen the vertical column will influence the category in the left hand column
C = each category influences the other equally
A+- = the same as A except that the left category has a positive or negative influence on the other category
B+- = the same as B except that the influence can be either positive or negative
D = each category will positively or negatively influence the other category
E = each category influences the other, the left hand column will positively or negatively influence the vertical column
F = each category influences the other, the vertical column will positively or negatively influence the left hand column
- = means that there is no relationship between the categories

EXPLANATIONS OF THE CATEGORY RELATIONSHIPS DISCOVERED

The following are some sample explanations from the chart showing the relationships of the categories within this educational environment. These include "A+-", "C", "D" and "E" type of relationships.

The software category (1) relates to the hardware category (2) with a "C" type of relationship which means that each category influences the other category equally. This means that the choice of software will influence the choice of hardware and the choice of hardware will influence what software can be chosen, but neither of these influences the other causing a positive or negative outcome.

The relationship between the software category (1) and the learning & measurement category (6) is an "A+-". This means that the choice of software can affect the learning and measurement that takes place in either a positive or negative way. For example a "good" piece of software can have the effect of creating a positive learning environment. And a "bad" or ill-suited piece of software can create a negative learning situation or have poor possibilities of measuring the learning.

The relationship between the accessing category (3) and the control & choice category (10) is a "D" which means that they can positively or negatively influence the other. The accessing environment can be set up in a way to create positive or negative control & choices for the student. And the way the choices & control are given to the student can cause a positive or negative accessing situation.

The relationship between the verbal input category (7) and the concentration & motivation category (9) is an "E". This means that the verbal input can be either be a positive or negative influence on the student's concentration & motivation. For example, appropriate and well-timed verbal input can provide for a positive influence on the student's concentration & motivation and if badly timed the verbal input can have a negative effect on concentration & motivation.

Some of the conclusions that can be drawn from this chart are as follows:

1) The chart shows that the software category (1) interacts with twelve of the categories, (all of them excepting the classroom environment category). It may be concluded that this is the central category in this educational environment because almost all other categories interact or are influenced by it in some way.

The centrality of the software category has implications for an individual session with Walter, for other students at the Mackay Center and for cerebral palsy students elsewhere. The implications are that when the software is chosen or changed it will involve or influence the circumstances of many other categories in the environment. In this case it will have an effect on all the categories except the classroom environment. This effect could be positive, negative or an equal effect. (See Table 1).

2) There are a few other central categories:

- teacher's goals (8) interacts with eleven other categories,
- concentration & motivation (9) interacts with ten other categories,
- control & choice (10) interacts with ten other categories,

- communication (11) interacts with nine other categories and
- learning & measurement (6) interacts with nine other categories.

CONCLUSIONS & RECOMMENDATIONS

CONCLUSIONS

1. My first conclusion is that the actual input/output accessing of the computer is a very vital and essential part of the process for a cerebral palsy student using a computer in an educational setting. Making this as effective as possible is a necessary step. The accessing (which means the physical and cognitive interface (ergonomics) with the computer) varies with the task required by the piece of software and may take some trial and error to set up adequately to meet the individual students' needs. If this is not done with a good understanding of who the student is, and what the software is all about, then there tends to be a lot of frustration and hence a decrease in motivation on the part of the student. For example: the occupational therapist stated that Walter needs to have his splint on to prevent further contractures in his wrists and to use his right hand because it gives him better control. But he likes to sit with his left side beside the computer and this causes him to stretch the muscles in his neck and arms into poor positions, so it is recommended that he sit facing the computer. Refer to the Accessing chart (Appendix B) for a description of the different types of accessing done with the different pieces of software. There is a conflict between what is good for Walter and what he likes to do, which has to be resolved. For instance Walter wants to sit with his left side by the computer and he feels more motivated when this is allowed, but the trade-off is that he has less accuracy and it is a poor physical position for him to be in. If he sits straight-on facing the computer he is initially less motivated but has more accuracy and is in a better physical position.

The important aspects of different pieces of accessing apparatus are shown in the Accessing chart (Appendix B) and a detailed summary is at the end of that Appendix.

These conclusions are based on my observations and participation for the duration of time it took to set up and evaluate the use of a piece of software to suit Walter's needs. Use of the software Reader Rabbit required that there be some experimentation in deciding where to put the squares on the Unicorn keyboard and it was necessary to move it around so Walter could reach the various squares, this gives evidence to support the idea that keyboards need to be set and modified to meet the students' range of movement. These conclusions are also based on the evaluative suggestions made by the occupational therapist.

2. The efficacy of using a computer in this environment for Walter is dependent upon his level of interest in what is being done. If he is unchallenged by a particular situation then he becomes unstimulated and bored. (This conclusion is also partly based on statements of his primary care workers' experience with him).

BENEFITS OFFERED

The conclusions about what a computer can offer a cerebral palsy student in an educational environment are as follows -

a) The computer can offer assessment possibilities in the academic areas of learning, reading sight words and number recognition. The programs used for reading were First Letter Fun, Reader Rabbit, Kidwriter, Wordburner and Aquarium. (Please see the Software Table, Appendix C, for detailed results of using this software). In using the program First Letter Fun, there was a choice of categories and Walter showed a preference for the

"Farm" category which is a familiar context to him. This offers some proof that words that are contextual are motivating for Walter and his primary care worker supports this idea as he has seen Walter likes to have control with things that have meaning to him. Reader Rabbit offered a way to learn words by matching them to pictures in a memory game format. This was fairly successful as certain words were learnt in each session but there was not enough consistency in what was done between the sessions for it to be assessed whether he remembered things and was learning from one session to another. Kidwriter was used for recognition of certain letters and the words cat and dog. It was shown that this worked fairly well as this software did enable assessment and there was consistency between sessions. Wordburner was a more sophisticated tool in that it provided the ability to put in the words one wanted, therefore more closely relating this to a students' needs. It also has the ability to provide a report on what has been done by the student. All in all this is a good assessment tool. The use of the Aquarium program provided an assessment of Walter's ability to access single letters and this was good because it was consistently the same and done often.

b) The use of a computer does offer some experiences of being in control that a student might not otherwise have and there are also some areas of computer use that are lacking by not allowing control. This is supported in the following examples but also supported by what one of his teachers stated in an interview. In using the Tic Tac Toe program this allows Walter to experience developing a strategy and using it to control his actions in playing this game by himself and against the computer. In using the Aquarium program Walter learned that by pressing the "S" key he could

stop the program and he would exercise some control over the process of the program. There is less control offered in the setting up & starting of the programs as it requires teacher assistance to put the disk in the computer and turn the computer on. Also there are a lack of menus, that could possibly allow the student to pick a particular program. This results in the student being dependent on another person to set things up for them, thus reducing the amount of control the student has over the situation. Being able to move and change things on the screen is an element of control that these students experience. Also, Walter may have a tendency to use the computer to control people in situations. This comes through his on/off desire to use the computer and this may be a form of communication he uses.

The use of the Speechviewer program, even only on one day, allowed Walter to experience controlling something visual with his own voice and also a chance to experience his voice being played back along with a graph of the tone of his voice. This could also be done with a tape recorder but it wouldn't have the visual feedback aspect that this program provides.

c) In using particular pieces of software there is opportunity for interaction with other people to take place if that is what the software requires. It was observed that during the use of this type of program in September 1990, that Walter was very motivated by the interaction aspect of this. And Heather stated from her experience of working with Walter that he loves interactions with people.

The computer offers a chance for the student to play recreational games and these games were played with several people thus providing for social interaction. Walter developed certain bonds and friendships as he liked to play certain games with certain people.

3. Using the computer can offer a forum for self-expression of a student's likes and dislikes. For Walter the advent of his electric wheelchair provided him with the ability to show what he liked as he could demonstrate this by moving himself in particular situations. Since he had the mobility he could show that he liked to use the keyboard on the computer because he would arrive and go directly to the computer and set himself up to use the keyboard with his left hand. Also in playing games Walter showed he liked to have competition (playing Tic Tac Toe) and liked to have human interaction while playing. The use of the software Logowriter offers a tool of self-expression in using arrows to draw on the screen.

4. Direct personal communication with the student during the use of the computer is vital for productive sessions. In this case study if Walter was not understood then he would become unmotivated and his desire to continue with the task would go down. Since communication is so important for non-verbal students (as well as everyone). They are often misunderstood because their gestures are missed or what they "say" is not confirmed with them. This can be seen when Walter's baby brother was born and he wanted to communicate this to everyone. This was not adequately picked up by those around him and as a result he refused to do anything. Another aspect of communication during the session that is important is dependency. Walter came to rely on the reassurance and encouragement of the teacher and when this was taken away from him he became quite reluctant to continue with the session.

Since the nature of the educational environment for a cerebral palsy student is a very interdisciplinary one with input being received from many

sources - i.e. physiotherapists, occupational therapists, speech therapists, augmentative communication, classroom teachers and a computer teacher, the communication amongst all these people is very important because they all have a part of the picture of the student. In order for a successful session to happen at the computer all these aspects and points of views need to be taken into consideration.

5. The use of certain programs show particular skills. The program Wordburner requires that a student first see what is on the screen, scan it, and plan when to hit the switch, then concentrate until that time comes and press it. It was seen that Walter was able to do this when using this program. It was thought beforehand that Walter was not able to scan things and then plan but by using this program it can be seen that Walter can do this and gives proof to his analytical capabilities.

6. It can be concluded that through the use of Wordburner (see Appendix C) that it is not always consistent what Walter knows with this program although it has good assessment capabilities. What is meant by this is that it often varies from day to day which words Walter appears to know. He seems to know the words mother, father, sister and baby quite consistently and in each session he seems to get about 25% correct on the first try but it is not always the first 25%.

7. The computer provides an opportunity for tactile involvement and experience. Since, for most cerebral palsy students tactile experience has been rather limited in their development, the use of the computer provides an opportunity to experience this through pressing the single switch, the keyboard and to a lesser degree the Unicorn keyboard (where the student uses his/her whole hand). Walter showed a keen interest in using the

keyboard and seemed really motivated by this. Also during the springtime he insisted on grabbing my pen with his left hand and trying to write with this on a piece of paper. He seemed to be really happy that he was able to do this. This idea could be a used as a basis for providing further opportunities for tactile experiences that result in experiences of control and seeing visual results from physical motor movements.

8. Some further conclusions can be drawn based on the relationship flow chart (Figures 3 & 4) and also from the chart showing the relationships among the categories (Table 1). It appears that the software category (both cognitive ergonomics and curriculum aspects of it) is the most central to this environment, as it interacts with twelve of the other categories. The teacher's goals, concentration & motivation, control & choice, communication, and learning & measurement categories all interact with nine or more other categories.

From the relationship flow chart and the chart of categories a more general statement of optimal procedures can be made: It is that the teacher's goals influence what academic skills are chosen, then the software is chosen based on the academic skills and what motivates the student, accessing is then developed related to the student's physiology and the hardware and software being used, the software is assessed and the learning is measured and then new goals can be formed about that particular student and then the cycle continues. It can be said that the communication aspect is an integral part of this system. It is like a oil that keeps the system flowing and keeps the integrity of the system intact.

9. Two of the methods used in this thesis (the Educational Cybernetic Model - Figure 1 and the Category Relationships - Table 1) can be combined.

The categories from Table 1 can be clustered into the eight cybernetic variable classes. This is done in the following manner:

Cybernetic Variable Class	Category Name
Teaching Algorithm	Assessment
	Verbal Input
Subject Matter Variables	Academic Skill
Target/Standard Variables	Teacher's Goals
Physical & Psychostructure Variables	Concentration & Motivation
	Control & Choice
	Student's Physiology
Sociostructure Variables	Communication between people
Teaching System Variables	Software
	Hardware
	Accessing
Learning System Variables	Learning & Measurement
	Student's Life
Environment Variables	Classroom Environment

The categories can then be related to one another in the same way as the cybernetic classes are shown in Figure 1.

10. In this thesis I attempted to use grounded theory methodology, action research and cybernetic modeling to study this environment. I found

that using a combination of these methods worked best for this environment as the grounded theory provided methods for data collection and analysis, action research was used as a basis for studying the causes and effects, and cybernetic modeling kept holistic checks on completeness of analysis.

I recorded my observations and participation from each session as well as the students', teachers' and others comments and questions that took place. This was followed by analyzing the data for core concepts and cause and effect processes. A careful study of each concept was done looking at its respective conditions, consequences, interactions, strategies and tactics (conceptual elaboration). This resulted in a group of 14 main concepts (categories) in the environment as shown in the directed graph matrix (Table 1) from which many conclusions here arose.

Even though my original role was as a participant-observer, I also acted as a communication link between three of the class settings and was able to relay the happenings of those sessions to the teachers in charge.

I want to comment that this type of case study is a lengthy and solitary process and it was difficult at times to keep my enthusiasm going. I would recommend a somewhat shorter study by reducing the study time to 4-6 months or having a more focused goal (i.e. studying only one type of software). Still keeping in mind that an holistic approach is needed to do justice to this complex environment. It was helpful to have had a familiarity with these students from my previous experiences with them in summer camp, aquatic and internship settings.

Finally, I would recommend these methodologies for the study of any complex educational environment (keeping in mind my comments about the process).

RECOMMENDATIONS

1. The use of data that is contextual to the student has been shown to help in the motivational aspect of the situation. This was shown in Walter's case by him deliberately choosing to do things that were related to a farm which is something he is familiar with. One other idea that would be contextual is to have Walter learn to type his own name. Since using the keyboard is hard for Walter this was tried at a later time when he is ready, but meanwhile this could be given to other students who are more adept at using the keyboard. I would recommend and make a generalization that, using things that are contextual, be done for other cerebral palsy students because it can only help in the learning situation since it is giving them the advantage of starting with something they are familiar with.

2. From the observations of the school's attempt to assess and help Walter's learning English words. There seemed to be a bit of inconsistency in the words that were given in the different classes. This may have made some difference in the amount that Walter actually learnt. I would recommend at least a core set of words be used in the different sessions and programs, that is if this is feasible with the programs. The only hindrance to this is that, as in Walter's case he may become bored with the repetition of the words but this can be monitored. Also a consistency in the words amongst the programs could allow for an evaluation to be done on the software to see which programs provide a better learning experience for the students.

3. As has been mentioned many times, accessing (Hardware I/O) is a very critical aspect of the process of a cerebral palsy student using a computer. I would recommend that a lot of attention be paid to this aspect and to remember that the accessing needs to adapted and monitored to fit each individual student.

4. Through using the computer a cerebral palsy student is offered a wide variety of experiences that they may not otherwise have the chance to experience (see conclusions 2, 7). I would make a general recommendation that the student with cerebral palsy use computers because of this opportunity. Also it may be discovered that there are other skills that the student has or other computer opportunities that will be discovered by just starting the use of the computer.

5. Communication while using the computer is vital. Both the communication before using the computer and during the use of a piece of software is required. It was observed with Walter that during his use of the computer that his Bliss book was taken away from him thus leaving him only with the capacity to respond with yes/no gestures. I would recommend and generalize that for all non-verbal cerebral palsy students that they have some sort of communication device accessible during the time that they are using the computer and also that their communication devices have in them all the Bliss symbols or words related to using the computer.

6. I would recommend that when planning a student's goals it seems necessary to take into consideration the student's current life circumstances and also future considerations(i.e. what is the vision for the student). This

seems necessary because if the student has one particular kind of computer at home or will be going to live in a place that has particular types of computer then this needs to be taken into consideration when planning what type of computer a student works with and what type of accessing is done for the student.

7. In this particular case study it was recognized that there was a lack of co-ordination among the people who were working with Walter. This almost seemed like a natural occurrence because there were so many people working with him and the education of a cerebral palsy student relies on an interdisciplinary approach. But this can cause problems because for example in Walter's case it was often not known what steps and progress were being made by the other people that were working with him, since there were eight different people who had worked with him on different particular aspects. I would generalize that this could possibly occur with other cerebral palsy students and recommend two possible solutions which are:

- to have one person be in-charge of each student and co-ordinate what goes on with him/her.
- have a regular information-exchange meeting so that everyone is aware of what is going on and negotiate what the goals are and what the primary direction is for the student.

8. The larger relationship flow chart (Figure 3) and the flow chart of individual sessions (Figure 4) contains many cause and effect relationships among major factors (categories) in this computer/student environment. These show the decisions that are made and some of the factors that affect

those decisions. Three major recommendations can be made from this: (See Relationship Flow Chart - see Figures 3 & 4).

- One needs to understand the student's physiology well in order to provide good accessing. The effectiveness of accessing varies positively or negatively according to the degree of understanding of the student's physiology and the monitoring of this process to modify it as need be.

- Three factors directly affect Walter's motivation with a task and this in turn affects the quality of assessment or learning. These are: the supportiveness of the classroom environment (i.e. Walter will get distracted quite easily by noises made by the other students), his ability to communicate and feel understood, and his ability to have control of what is happening during each session. If all these three factors are well taken care of then the student's motivation will be high and if they are done poorly then the motivation will decrease.

- Communication among the people who work in the environment influences the goals and aspirations for the student and in turn increases the effectiveness of the whole process of education. Good communication, and a recognition of where communication is lacking, results in a better functioning process. Poor communication or a lack of recognition of where communication is lacking, causes poor results in the process and frustrations of both teachers and students. (Note: this generalization is supported by what is stated in the Conclusion 4 page 86, Research question 4 page 99 and with respect to Recommendations 5 & 7 pages 92-93.)

TRANSITION NOTE

These recommendations and conclusions are based on the data collected during my participation and observation sessions and using the qualitative methods of data analysis.

It is hoped that the conclusions and recommendations can benefit, the student Walter Torland and other cerebral palsy students. Answers to the proposed research questions follow as well as some further research questions for those involved in this area.

ACTUAL RESEARCH QUESTIONS & FURTHER RESEARCH QUESTIONS

Results of research questions proposed before case study started are as follows:

1. Question: What are the special characteristics of a computer and the ways computers and software can be adapted to enable and enhance the education for cerebral palsy students?

From the research conducted in this case study this question is answered in the following ways:

The ways computers are adapted to cerebral palsy students is through the various accessing techniques. The Unicorn keyboard can be adapted to suit different software. Whatever keys are required by a particular program can be placed on the Unicorn keyboard overlays in the places that are most suited to the range of movement of the student.

The moveable keyboard is crucial because again it needs to be placed in the "correct" position for each individual student to be able to reach the required keys. An adjustable table as shown in the Figure 2 makes things easier to suit the individual student vis a vis the height of the screen and keyboard.

The ability to set the timing in a program is crucial to meet the needs of the student because if the timing is too fast it will cause a lot of unnecessary frustrations for the student and if it is too slow the student may become bored. This is a special characteristic of the software and one that can be set up to suit the student and then modified either to train the student to

respond faster or slower whatever may be the case, it can be adjusted accordingly.

Another way the computer can and must be adapted is to de-activate the repeat function on the keys of the keyboard. It is necessary to do this if the student can't remove his/her hand in enough time so as to not cause a repetition of the keys.

Other special characteristics that using the computer offers cerebral palsy students are some things that have been mentioned in the final conclusion section such as:

- the computer offers tactile experiences (conclusion 7)
- opportunity to experience control and seeing results of actions (2b)
- explore things not otherwise experienced like playing computer bowling and playing computer Tic Tac Toe which may have never been played on paper.

One really important aspect that has been observed and also stated by Heather in an interview is the fact that by offering a wide variety of experiences for a cerebral palsy student this may lead to the discovery of other skills a student has or other learning possibilities. For example people observing what is happening may discover other things about the student. This was observed several years ago when the augmentative communication teacher who was working with Walter using the Kidwriter program observed that he had good spatial skills. This was then relayed to the physiotherapy department and the idea transferred into giving Walter the opportunity to use an electric wheelchair, since it was now known that he had spatial skills and the capacity to use them. It was previously thought that he had poor spatial skills.

2. Question: Can a computer help in the assessment and evaluation of a cerebr ı palsy student, assist in cognitive development of letter and word recognition, and offer other areas for assessment?

Most of this question has been answered affirmatively in the final conclusion section. (2a). This can be backed up by with statements received in interviews with various teachers. A small assessment of the student's knowledge of numbers was done with the program Davey's Digits. One teacher stated that "yes" these programs do offer ways to assess the abilities and knowledge (English words) of students such as Walter -- Such as Wordburner, Reader Rabbit, Kidwriter.. . This same teacher stated that the computer is a good alternative to regular assessment methods because Walter can respond directly and not have to go through another person who may influence or misinterpret his reply. This problem of misinterpreting responses is so common because of the non-verbal aspect of many of these students' communication. This needs to be taken seriously.

3. Question: Can one learn a lot about a cerebral palsy student by using a computer?

One can learn something about what a student knows through using the software for assessment. Also one can learn about the student's capacity to use certain skills that the program requires. Such as in the Wordburner program it requires planning, scanning, and concentrating. Using the

programs Tic Tac Toe and Bowling show whether the student can demonstrate eye-hand co-ordination. This skill is not only demonstrated in games but other programs as well, but it seems to be more of a focus in the games whereas in more academic software it is the academic skills that take precedent.

One can also learn something about a student's learning strategy. In the program Reader Rabbit where visual matching was required it could be seen that Walter used the strategy of turning over the last one he had seen thus assuring that he would remember at least one of the pictures he had seen. Also in the Wordburner program it could be seen that Walter relied on the verbal prompting of what was on the screen and verbal recognition and affirmation of what he had done. (This was provided by the teacher or assistant with Walter during that session.) He seemed to require this in order to continue with the program.

4. Question: What are the students and teachers feeling in this environment? What works best for the feelings of this student? Why are things being done in this environment?

Walter's feelings are mostly understood by observing Walter's gestures and expressions during different phases of the sessions. Walter will show lack of motivation or dislike of something by a facial grimace and sometimes he'll drive away from the activity. Or he'll physically remove his hands from the keys. If he's tired he'll show this through slow movements and if he's angry he has often tried to bite the person's arm next to him. If he's

really enjoying something he'll smile and laugh or make some form of joke (He has shown he has a really good sense of humor).

The computer teacher Heather, has many feelings related to what her goals are for working with Walter. Often her goals are not necessarily what Walter wants to do and sometimes what she does is a stepping stone to other things and she isn't sure that he understands this. She also has a big concern for the things she does being connected with the goals of the other teachers. She recognizes that communication is often a barrier with non-vocal students and feels she needs to give more time than she is able to give to this issue and feels she doesn't do this for fear of wasting time. She also has a fear of "fragmentation" (in the content of what is being done with Walter) because there are two or more people working with him and they are not always communicating about what goes on in each session, therefore there is a lack in continuity of knowledge among those working with Walter. Communication seems to be a common denominator and she suggests spending ten minutes at the beginning of each session talking with him and in coordinating each of their needs so they can get Walter to select a commonly desirable activity. Also having a communication book going between the classes would assist in the continuity of communication and the transfer of knowledge. Because of the nature of the work I was doing in attending both these classes I became a middle person and could relay information back and forth between the classes.

A classroom teacher says her hopes for Walter are that he will live in a milieu where he will be happy and be able to communicate all of his needs and desires and have enough stimulation to ensure that he grows both intellectually and socially. Her goal is to help him acquire the skills he'll

need for the future especially in the area of communication. Her fear is that when Walter is in a new environment he won't have the same type of services and his stubbornness will be a deterrent to future development.

Another classroom teacher that works with Walter has the goal that to find something that Walter can occupy himself with in the future and to use programs for assessment for reading, and letter recognition. Walter's primary care worker has the goals of urging him to communicate using complete sentences and to reinforce the idea that he can go way beyond his limits in the expectation that when challenged he'll rise up to it.

In response to the question what works best for these "feelings" of the student, Walter, some ideas are:

- for Walter's motivation, effective communication is a key - Heather wants to pick up on this and have ten minutes at the beginning of each session, another classroom teacher feels his ability to communicate what he needs is a key as well. Hence through good communication practices perhaps both Walter's needs and Heather's needs as a teacher can be accomplished.

As to the question of why are things being done in this environment? Things in this environment are being done because of what is understood as the goals and feelings of those involved. It is only when these are in agreement and good communication exists or, when someone recognizes that what is being done and what is desired are not congruent, that this environment is adjusted and functions intune with people's goals.

QUESTIONS FOR FURTHER RESEARCH

1. How is it possible through the use of a computer as a tool to have a better understanding of how a non-verbal student communicates and can it provide new ways for communicating?

2. Is it possible to determine whether a Cerebral Palsy student has memorized the placement of words on a screen or is he/she actually reading the words or letters? This question arises during the use of many of the software programs that require the student to recognize words and or letters of the alphabet on the screen. (Location vs. shape ambiguity)

3. Do students understand what is meant by the "first letter", and if the idea of first letter is related to the student's concept of numbers because we are dealing with the idea of first?. (In this case study Walter had difficulty with number concepts and perhaps there is a general difficulty for all Cerebral Palsy students.)

4. In what ways can the computer offer tactile and kinesthetic experiences that these students are not normally exposed to?

5. What impact does it have on these students to experience voice control using software like the IBM Speechviewer?

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APPENDIX A

TABLE 2 - LONG & SHORT TERM OBJECTIVES FOR THE STUDENT 1990- - 1991. LEARNING, PSYCHOSOCIAL AND PHYSICAL

(All items that are numbered are those that were worked on in the computer area during this year and are described at the end of this chart.)

NEED	LONG-TERM OBJECTIVE	SHORT TERM OBJECTIVE
Learning	- Bliss computer at home	- Work on reading, writing, Bliss and English (1)
		- Increase sight word vocabulary (2)
		- Increase the number of programs on the computer(3)
		- Using more Bliss symbols and initiating more conversations - Augmentative Communication goal
		- Learn how to use the Touch Talker - Augmentative Communication goal
Psychosocial	- To be as independent as possible in communication(4)	- Increase the level of communication (5)
	- Participate in community activities	- Increase the number of people he communicates with
	- Increase in leisure time	- Assume more responsibility as a communication partner
		- use touch talker system in daily life as a life-aid and for communication - Augmentative Communication goal

		- participate more in group discussions i.e. be less passive - Augmentative communication staff will continue to provide support to others.

NEED	LONG-TERM OBJECTIVE	SHORT TERM OBJECTIVE
Physical	- To be as independent as possible in mobility (6)	- Others to be aware of the students' poor vision and his ways for compensating this.
	- Improve upper body	- Prevent further contractures of his wrists by wearing wrist splints during the day. (7) - Access the computer with a variety of input devices so the computer can be used in more situations. (8) - To have a new display design.

The following describes what has been done during the year to meet the objectives of those indicated with a number in the above chart.

1 - The reading of English words was worked on in the use of the software - Wordburner, Reader Rabbit, Kidwriter, First Letter Fun, Binary Writer and Aquarium. Also, a new page with, a word chart of all the different types of computer software, was added to his display book.

2 - The goal of increasing sight word vocabulary was worked on especially during the use of the software "Wordburner". This program allows one to enter whatever words one wants to and in this case the desired sight words were taken from the student's Bliss display. Sight words were also worked on by using the program Kidwriter in which specific words could be used (the words used were "cat", "dog", "boy", and "girl").

3 - The goal to increase the number of programs that can be used by the student on the computer was done by introducing and trying the following: Davey's Digit's, Binary Writer, First Letter Fun, Reader Rabbit, Kidwriter, variations of Logowriter, Wordburner, Aquarium and Fishing.

4 - This action of putting more words in the Bliss display book would allow for more independent communication.

5 - This action of having new words in the Bliss display and having a better knowledge of sight words this could also indirectly increase the level of communication.

6 - The experimentation and use of a variety of input devices may assist in the student becoming more independent in his mobility. This variety of input devices would allow him to be more adaptable to different locations that may require using different input devices.

7 - The incorporation of using wrist splints is also a vital part of the student's using the computer adequately. If the wrist splints are not on, the effectiveness of accessing will be diminished and also the splints are necessary to prevent further physical difficulties.

8 - During the course of the year the use of a single-switch, keyboard and the Unicorn keyboard were done. Thus allowing the computer to be used in more situations.

APPENDIX B

SUMMARY OF ACCESSING SKILLS

UNICORN KEYBOARD

An alternate input device, with a flat membrane keyboard with overlays that can be configured as required by each piece of software.

Software	Accessing skills required by that device	
	Vision of keyboard and the screen	Pressing a flat square with pressure from any part of the hand
READER RABBIT		
Feb 4/91	- good	- difficulty pressing the return key and the upper arrow key (near the top) and keys on the far left
Feb 11/91	- good	- no splint on but still good ability to access
Feb 15/91	- some difficulty, needed prompting to show where things are on the screen.	- right hand gets stuck on the down arrow of the keyboard when there is no further for it to go on the screen (it reaches bottom of screen)
Feb 18/91	- need to point out the arrow on the screen.	- good
UNICORN KEYBOARD	Vision of keyboard and the screen	Pressing a flat square with the pressure from any part of the hand
KIDWRITER		
Feb 25/91	- mixes up boy and girl pictures, otherwise good	- good, very familiar with this piece of software.
March 11/91	- good recognizes all things	- good, timing not a factor in this program
March 25/91	- good	- good, does independently

April 8/91	- good	- board keeps needing to be moved so he can reach the forward and backward, and arrow keys which are on the far left. Also his hand gets caught on the right side of the keyboard.

UNICORN KEYBOARD	Vision of keyboard and the screen	Pressing a flat square with the pressure from any part of the hand
AQUARIUM		
March 13/91	- fair	- sometimes his hand slips onto the key beside the one he wants
March 18/91	- good	- ditto
April 8/91	- good	- need to move the board to meet his range of movement
April 11/91	-took awhile to to get things set up,vision was good	- ditto
April 22/91	- good	- he wanted to use the keyboard only for the setup. Then used the Unicorn keyboard.
April 24/91	- good	- ditto
April 29/91	- good	- ditto

May 13/91 & May 22/91 see regular keyboard section.

SINGLE SWITCH

Software	Skills required in using this accessing device	
	Pressing the switch with left hand at the correct time	Removing the hand from the switch in time
BINARY WRITER		
Oct 15/90	- does this with prompting as to what is on the screen	- fair
Oct 29/90	- better, picks out letters by himself	- better
Nov 19/90	- wants to use the keyboard	
TIC TAC TOE		
Oct 26/90	- fair	-good
Oct 29/90	- improving	-good
Nov 16/90	- good	-good
Nov 19/90	- some prompting of directions to help with what is on the screen	-good
GREEN BOWLING		
Oct 26/90	- fair	-fair
Oct 29/90	- turns head at inopportune times, missing the best time to hit the switch	-fair

Nov 19/90	- his timing is a bit slow to hit the switch	-fair

APPLE BOWLING

Oct 26/90	- good	-good
Oct 29/90	- very good	-good

SINGLE SWITCH	Pressing switch with left hand at the correct time	Removing the hand from the switch in time

WORDBURNER

April 22/91	- fair	- some delays
April 29/91	- dependent upon teacher for encouragement	- distracted when teacher leaves, forgets to remove his hand from the switch
May 6/91	- distracted when teacher not present	- fair
May 13/91	- presses too early sometimes	- fair
May 26/91	- looks away due to spastic movements and misses pressing at the appropriate time	- spastic movements sometimes cause him to keep his hand pressed on the switch.

KEYBOARD

Software	Skills required in using the accessing device	
	Knowing and finding the location on the keyboard to press	Pressing the desired key
DAVEY'S DIGITS		
Oct 22/90	- knows spacebar	- good
FIRST LETTER FUN		
Dec 3/90	- knows spacebar, learns return	- can press spacebar and presses return with removal of keyguard
Dec 10/90	- uses left hand and presses spacebar to move arrow around	- takes two tries to get the letter
Dec 17/90	- presses spacebar	- good
June 10/91	- presses spacebar	- not looking at screen when pressing spacebar
LOGOWRITER		
Nov 2/90	- difficulty in recognizing the arrow keys	- fair
Dec 3/90	- changed to have areas on keyboard that represent four different directions	- some difficulty but better at spacebar
Dec 7/90	- use of right hand, took some time to understand new areas	- some difficulty but is motivated
Dec 14/90	- keyboard on wedge, able to	- hits the "7" by mistake,

	press letters "r" & "t",	good control of fingers
LOGOWRITER - Alphabet		
June 12/91	- use of spacebar	- he knows and presses this well
KEYBOARD	Knowing and finding the location on the keyboard to press	Pressing the desired key
AQUARIUM		
May 13/91	- knows letters "A","F","S" letter "N"	- difficulty pressing
May 22/91	- tape on keys to assist in recognizing what keys are to be used	- using hand and thumb of left hand, difficulty at first, also finger stays on key too long causing large numbers of one type of fish to be added.
FISHING		
April 16/91	- knows keys "D" and spacebar, doesn't know letter "U"	- able to press spacebar, but finger gets stuck on letter "D"
May 22/91	- tape was put on letters "U" and "D", especially to help him know letter "U"	- presses the letter "D" but doesn't know the "U"

There were other accessing devices that were experimented with by one of the teachers whose role is to try new things with Walter. A brief description of those tried are a follows:

JOYSTICK - the joystick was tried on Nov 26/90 by Heather in relation to the program LOGOwriter. It is used as an input device that will simulate the arrow keys on the keyboard. It requires a delicate response. This is hard for him to co-ordinate his movements of the joystick with the directions on the screen.

ROTARY (TRACK) BALL - Walter showed some interest in trying this as he kept reaching for it during the session when he was using the joystick. Although this was not tried separately.

APPENDIX B - SUMMARY OF ACCESSING DEVICES

Unicorn Keyboard: Walter has generally good vision of this keyboard. The main problems seem to revolve around the placement of the squares on the board so that they are easily accessible. The placement of the board needs to be within easy reach for the student, since it sometimes needs to be moved for the student to be able to reach all of the squares. Also a problem occurs when Walter's hand slips off the square he wants to press or gets stuck on the bottom of the board and it is necessary for someone to monitor when this happens. It is necessary for someone to monitor this because it affects Walter's performance on that piece of software.

Single Switch: This requires that the switch be pressed at the correct time by the left hand and then the hand must be removed from the switch to be ready for the next response. Sometimes Walter needs prompting as to when to hit the switch and sometimes his spastic movements cause him to turn away and miss the appropriate time. Otherwise he does this fairly well. Most of the time he can remove his hand in time but during the use of "Wordburner" he becomes quite reliant on the teacher's prompting and gets distracted when the teacher is not there and forgets what he is doing on the single switch.

Keyboard: Walter likes to use a "real" keyboard when possible. He appears to know the positioning of the spacebar and letters "A", "F", "S", & "D" but he has difficulty with the arrow keys. Perhaps he knows the spacebar because it is the largest key on the keyboard. He is generally fair at accurately pressing the keys and sometimes has difficulty when his hand stays on a key too long causing it to repeat. In most cases it is possible to

disable the repeat function on the keys.

APPENDIX C

SOFTWARE TABLE
(Showing Walter's progress with the skills in a piece of software

Software Name	Skills Used in Piece of Software		
DAVEY'S DIGITS	Visual recognition of numbers	Shows understanding of the number concept by doing taps on spacebar	
Oct 22/90	- no remarks	- knows numbers 1&3, difficulty with numbers 2,4,5, mixes up 2 & 5.	
BINARY WRITER	Visual scanning of alphabet	Hitting single switch at correct time	Visually recognizing the aural request of a letter.
Oct 15/90	- fair	- does this with human prompting	- recognized "D" with time
Oct 26/90	Walter unmotivated today, so switched programs		
Oct 29/90	- improving	- better	- chose his name with no problem
Nov 5/90	Walter refuses to do this except if he has free reign to hit whatever he wants to.		
Nov 19/90	- fair	- wants to use keyboard	-didn't find Tony or letter "N"
TIC TAC TOE	Understanding game strategy	Hitting single switch at right time	Opponent
Oct 26/90	- fair	- fair	- Heather
Oct 29/90	- improving	- improving	- computer

Nov 16/90	- good, he won a game	- use of keyboard and single switch good	- Heather and computer
Nov 19/90	- good,won vs. computer and lost with teacher	- good	- computer then teacher

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GREEN BOWLING (the alley is horizontal to the screen)

	Hit single switch when ball is in a good position	Vision of screen and scanning
Oct 26/90	- fair	- good
Oct 29/90	- turns head at inopportune time	- fair
Nov 19/90	- takes time to hit	- fair

APPLE BOWLING (the alley is vertical on the screen)

	Hit single switch when ball is in good position	Vision of screen and scanning
Oct 26/90	- good	- good
Oct 29/90	- very good	- good

FIRST LETTER FUN Accessing using keyboard with keyguard, & propped up with a wedge to put it on a small angle. Use of spacebar and return key. Choice of scenes like park, magician, farm...

	Find the first letter of the word that identifies the picture	Press Spacebar to scan choice of letters. And return to choose the letter.
Dec 3/90	-finds the letters A,G, D,W,R,T. Mixes up U & Y. Farm scene.	-able to press spacebar and can press return better when keyguard removed.

Dec 10/90	-farm scene, finds A,G,H, C,M,D,W,F,G. And chose M for D and X for S.	-uses left hand and sometimes takes two tries to get the letter.
Dec 17/90	-Farm scene, knew letters A,W,D,F.	-Used spacebar well.
June 10/91	-Zoo scene, knew Z,F,K,B, H, C, D, F. Farm scene, didn't do well	-not looking at the screen when pressing spacebar.

READER RABBIT Accessing using Unicorn keyboard, large squares with arrows. Different sets of pictures (i.e. animals, travel).

	Matching picture to picture based on memorization.	Matching picture to the corresponding word.	Matching picture to the first letter of the word.
Feb 4/91	-kitchen, matched 2 in 9 tries.		-outdoors, matched 2 in 14 tries -did Walter memorize the spaces or read the words
Feb 11/91		-travel, matched 3 in 9.	-animal scene,match 3 in 14 with prompting. -no prompting, matched 3 in 10
Feb 15/91			-animal scene, matched 3 in 14.
Feb 18/91			-animal scene, matched 5/11 & 1/7

KIDWRITER Accessing using Unicorn keyboard, Bliss symbols on overlay.

	Alphabet, number and symbol recognition.	Translating instructions from the teacher into action.	Accessing
Feb 25/91	-Good except chooses a girl for	-puts members of family Understands this well	-good

	himself		
March 11/91	-Still chooses a girl for himself and things that start with "G" instead of "B"	-Do a bedroom and find things with letter "B"	-good
March 25/91	-Does this well -Chooses "C" then "D"	-Find things found in Park Safari -Find first letter of Dog.	-good
April 8/91	-Some confusion as he chooses a Dog and the first letter A.	-Find a Cat and the first letter of Cat	-good

LOGOWRITER Accessing using keys on keyboard divided into 4 sections to represent the four different directions

	Ability to see screen and know where arrows are.	Self-expression and control	Accessing
Nov 2/90	-fair	-drew straight lines with colors	-fair using arrow keys
Dec 3/90			-gave areas to represent directions
Dec 7/90	-fair	-motivated and did mostly down arrows which is done by the space-bar with the right hand	-gave a larger area for access.
Dec 14/90	-good	-good control with left hand	-keyboard on wedge, changed area

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LOGOWRITER Special version of this program brought by representative from Logo C.S.Inc. It alternates the letters of the alphabet in alphabetical order.

	Vision of screen	Pressing spacebar at correct time	Pressing single switch to choose letter
April 15/91	-fair	-concentrates intensely and wants to type his name	
June 12/91	-good		-letters change too slowly to keep his attention, so he plays and makes a screen full of letters

BLISS APPLE Accessing using a single switch

	Reading reference chart to find corresponding 3-digit number for the Bliss symbol.	Accessing using the single switch scanning - hitting it when the desired number is on the screen.
1989-90 School year	- fair, cumbersome to go through this process. Also problems with vision of the reference board.	-generally unmotivated because he wanted to use the keyboard and the single switch. -the accessing was also set up on the Unicorn keyboard to be used in residence to communicate a request for a video. This was difficult due to visual difficulties and also problems with the printer because it required special paper.

WORDBURNER Accessing using Single Switch

	Match the aural input to corresponding visual word and then find word on the screen	Accessing using single switch	Finding visual match of word on screen
Apr 22/91	-difficulty with the words mother,sleep,food,water, house,school,car,eat & go. It took more than 3 tries.	-fair	-not tried
Apr 29/91	-3 or more tries for words: bus,sister,home,food,boy, car,bed	-dependent on teacher for encouragement -distracted when teacher leaves, accessing lacks	-tried two and did fairly well with the word "bed"
May 6/91		-distracted when teacher wasn't present	-took two or more tries for mother, bus.
May 13/91	-took 3 or more tries for words baby & mother	-some difficulty with timing	-took two or more tries for mother,father, home, girl.
May 26/91	-took 3 or more tries for bus,school,sister,sleep, eat, bed	-looks away due to spastic movements	

AQUARIUM accessing using Unicorn keyboard then regular keyboard

	Translating verbal commands accurately into using keyboard	Accessing
March 13/91	-does the "add" command	-difficulty accessing hand slips onto next key before desired key is pressed.

March 18/91	-adds a zebra fish and food -likes to press the action oriented keys like air - bubbler, food and stop	-still some difficulty as the board needs to be moved so he can reach the far right
April 8/91	-added food and fish	-still have to move the board to suit students' needs.
April 11/91	-doesn't always follow instructions likes to have control and also distracted by others in the room.	-took awhile get placed so that the screen could be seen.
April 22/91	-commands written down on a large board to be read. -he read add angel & food but didn't know the word remove	-wanted to use the key-board and pressed a number for plants. -used Unicorn keyboard
April 24/91	-Added angel fish and food then read cards to add food, remove angel & baby guppy	-used keyboard to select plants then used Unicorn keyboard
April 29/91	-added baby guppy, neon tetra, male guppy and wants to press stop key which gives him much control	-still wanting to use key-board same as above.
May 13/91	-added neon tetra, angel fish, food, and knows how to remove something	-used keyboard because Unicorn keyboard not working. Had some difficulty pressing the "r" and "s" key with his left hand. He accepted help from me to press these.
May 22/91	-added tons of angel fish his finger stayed down on the key. Also added female	-using keyboard again, with the necessary keys. He used his left hand.

	guppies,neon tetras and food.	Difficult because finger stays on key too long.

FISHING Accessing using the keyboard keys - "U", "D" and spacebar

	Visual discrimination of fish on screen	Accessing ability to identify keys and hit at the appropriate time
Apr 16/91	-this is difficult on the first time using this program	-gets the spacebar and the "D" (to lower the fishing rod). Doesn't know the "U"
May 22/91	-Doesn't seem to watch the screen and know when to raise the rod in time to save the fish with out being eaten.	-put tape on the "U" & "D" keys. Still presses "D" but not "U"

SPEECHVIEWER Accessing via voice control (IBM equipment on loan)

	Use voice to control and what is on the screen, person speaks into a microphone.
Oct 19/90	- really motivated by this as this gave him a new experience of control.
	- increased voice causes a balloon to grow bigger and the mouth of a clown gets bigger.
	- also one's voice can be be recorded and played

back. This was a real
motivation.
This was not used again
because the loan of the
this equipment was
finished.

APPENDIX C - SOFTWARE CONCLUSIONS

These are not ranked in any particular order. They all have good features. It is up to the requirements of the student and teacher in each particular session as to what features are needed. The only exception is Binary Writer which was not helpful for Walter.

DAVEY'S DIGITS - this is a good tool for assessing number skills.

FIRST LETTER FUN - has available the farm context which Walter likes, this is a good tool for assessing recognition of the first letter of a word which identifies a picture on the screen. This requires that the student know how to spell the word.

READER RABBIT - this software requires visual matching of pictures, and pictures to first letters. This has good progress between words to first letters. There is no flexibility of input with this software.

KIDWRITER - uses Bliss symbols on the Unicorn keyboard. It has a good application of incorporating outside interests and is flexible. There is the possibility of using large letters and changing the size of pictures which helps with visual needs and may provide a motivational learning tool.

LOGOWRITER - this tool allows for self-expression through drawing and requires control of the arrow keys to draw or specific areas

of the keyboard. The student can be as creative as possible or follow the directives marked on the screen by the teacher.

BINARY WRITER - Walter is not motivated by this. The screen is hard to read.

WORDBURNER - this is a good tool for assessing the student's ability to find the visual word from the aural sound. This has the flexibility to input one's own choice of words suited to the student. Walter became dependent upon the teacher's prompting and encouragement. The software produces good statistics on each session.

AQUARIUM - this is a good action program that requires the student to match visual or verbal commands to the first letter of that command on Unicorn keyboard. The activity of pressing the letter "S" gave Walter a sense of empowerment as this would stop the program completely. This program also helps in assessing the knowledge of first letters.

GAMES - TIC TAC TOE - requires eye-hand coordination which Walter improved on over time. This can be a collaborative (interactive) game.

GREEN BOWL - the bowling alley is horizontal on the screen.

APPLE BOWL - the bowling alley is vertical on the screen, Walter

does better on this one.

Both of these bowling games require finer eye-hand coordination than other games.

APPENDIX D

PROBLEMS DISCOVERED AND OBSERVED AS OF MARCH 5/91

- there seems to be a fragmentation of goals for Walter, there is a fragmentation among the people that work with him. He sees 8 different people and no one seems to be in charge of him or coordinating him.

- there seems to be lack of communication among the people who work with him as to what their goals are and no common approach. This is how it appeared before the February staff meeting. Subsequently more focus was achieved.

- adapting software for Walter to meet the content of the lesson one wants. What is the content one wants for the lesson, this seems questionable and based on no common approach

- setting up appropriate accessing for the software - this can be done well; it just takes time to do and test to see if Walter can use it well

- Walter's change in moods and on/off desire not to do things - perhaps most of this is related to Walter having another agenda - although some say he needs structure, what happens when this occurs? If Walter wants something and this is not communicated or misunderstood then he becomes frustrated.

- this has definitely been a real discovery process of what to do with Walter, it really seems like it has not been well thought out before hand.
This is a very individual process and is not based on any other previous student.

- often difficult communication with Walter during the activities because he relies on those around him picking up his cues, gestures and yes/no responses.

-in some pieces of software the keys that have a repeat function become a menace because Walter's hand or finger may get stuck on a key. In these cases these repeat keys need to be disabled and many pieces of software have the option to do this.

GLOSSARY

1- ACADEMIC GOALS - these are the goals described in the IPP (Individual Pupil Plan) that relate to the academic skills such as reading and mathematics.

2- ACCESSING - this is the means by which the student interfaces with the computer, i.e. the form of input used by the student, such as single switch, AFC/Unicorn keyboard, regular keyboard with/without a keyguard.

3 - AUGMENTATIVE COMMUNICATION - this is a department of the Mackay center that looks at all the ways of augmenting a student's communication ability so that he/she has better and more effective ways of communicating. For a non-verbal student the provision of a Bliss symbol chart or book is done by the people working in this department.

4- BLISS - The Bliss Symbol System is used by non-verbal students to communicate. These symbols are usually placed on a tray on their wheelchair or in a binder book on their tray. The students usually communicate by pointing to the symbol of the word they want to communicate. The corresponding English word is placed under the symbol.

5- CONTEXT - the use of this word is in relation to the student and means

the things & words that are familiar to that particular student. The things that make up that student's environment at home or school, hobbies, favorite music, television programs or movies.

6- FUNCTIONAL GOALS - These are the goals related more to the functioning of the student. For example - communication, the number of programs he/she is able to use, the wearing of wrist splints to prevent further contractures of wrists.

7- INTERACTIVE - This is not the usual use of the term interactive in Educational Technology but is used here because the software is explicitly called "Interactive". A better term would be the word collaborative. This term is used for programs that use more than one person at a time and allow for interaction among the participants.

8- NON-VERBAL COMMUNICATION - This is communication done by a lot of students who have Cerebral Palsy and have no ability to communicate vocally, therefore they communicate using facial gestures, eye movements, head nods or by pointing to Bliss symbols in a book or on a display.

9- OPEN CODING - This term refers to the initial type of coding done during a research project. This is done by scrutinizing the field notes, interviews or other documents very closely (line by line). The aim is to produce concepts

that fit the data. This term is used by A. Strauss.

10- PHONICS - This term was used in conjunction with the goals for Walter's reading of English words. The phonics approach is more focused on the vocal sounds that correspond to the letter symbol.

11- SCANNING - The concept of input by scanning is associated with the use of the single switch. This means that there is an indicator on the screen that scans (moves) through the various choices of input for the student. The rate at which the indicator (usually an arrow or cursor) moves from one point to the next is called the "timing" of the program and this rate can usually be set at the beginning of the program and can be changed at any point during the use of the program.

12- SIGHT WORDS - These are the words a child knows by using them a lot, these are words a child sees a lot (a regular part of their possible vocabulary). These sometimes become a base for extending skills and phonics. For example, if the child knows the word house by switching one letter the word mouse can be taught.

13- SINGLE-SWITCH - this is a type of input used with many types of programs, with students who may have limited accessing ability. This term usually refers to a

2-inch square, flat surfaced switch which only requires one to press it at the desired time according to what is on the screen. It can be mounted so that it can be pressed by a hand, head, foot, knee, leg, elbow etc.

14 - SPLINT - A splint is what Walter wears on the underpart of his right and left forearms, hands and fingers. This is used to provide support, and allow for control of movements for accessing. It also is to prevent further tightening of the muscles in the hands due to the spasticity from cerebral palsy.

15 - TOUCH WINDOW - this is a form of input that has a screen placed over the monitor. This allows the student to press the monitor at the appropriate place for input.

16 - TRIANGULATION - This term refers to aspects of the data collecting phase that includes: using multiple data sources, such as written records, informants and observations. There is cross-validation among the multiple data sources. The validity is provided by cross-checking and constantly comparing incidents.

17 - UNICORN KEYBOARD & AFC CARD - AFC stands for the adaptive firmware card, which is a piece of hardware that the Unicorn

keyboard is plugged into at the back of the keyboard. The Unicorn keyboard is a flat yellow membrane that reads its own overlays adapted to each piece of software. The membrane board consists of 1-inch squares that can be programmed by using the AFC card to fit whatever type of keys are required for a particular piece of software. The squares can vary in size with a minimum of a 1 - inch square. When this is completed an overlay is ready for that particular piece of software.