The Use of Hypermedia in Cooperative Learning
Groups Composed of Students with
Heterogeneous Learning Styles

by

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Abstract

This study compared two methods of using a computer with cooperative learning groups. Hypermedia (HyperCard) and word processing (Microsoft Works) were used on a Macintosh computer by primary aged students to compile information based on a video presentation. Measures of achievement, retention and participation were made. Additionally, an attempt was made to assess learning preferences and compare performance for each of these computer methods with consideration for learning preference. Four main questions were posed:

• Does the computer used interactively and non-linearly, as in hypermedia, promote better assimilation of information than using the computer linearly, as in word processing?

• Does the computer used interactively and non-linearly, as in hypermedia, promote better retention of information than using the computer linearly, as in word processing?

• Does the use of hypermedia in cooperative learning with groups composed of members with heterogeneous learning preferences promote participation more than word processing activities?

• Does interactive hypermedia better meet the learning needs of more students than word processing regardless of learning preferences?

Data were collected from sixty three primary-aged students from four schools in the Vancouver Lower Mainland area. The same computer-based test was used on students as a pre-test, post-test and retention test. Teachers assessed participation by observing individual students for one minute at random intervals. Participation was reported as an average of the number of seconds out of sixty that students exhibited on-task behavior. A computer-based learning preferences assessment was devised to measure two broad categories of learning preferences based on Howard Gardner's Seven Intelligences. The same assessment was made directly by teachers and alternate classroom workers by dividing students into the two categories of learning preferences based on their observations. Teachers also reported observations of the activities pertaining to quality of interactions, teaching demands and predictions of future learning outcomes after long term use of each method.
The major conclusions of this study were:

- No significant differences in achievement or retention were found between the word processing and hypermedia groups.

- The HyperCard groups participated more than the word processing groups as measured by teacher ratings during the activities and as reported in the post-study teacher comments.

- More time for the activities is needed to yield clearer results.

- The tools used to assess learning preferences were not statistically reliable.

- Learning preferences for some students are likely fluid and changing and therefore difficult to assess.

- Increased participation scores for HyperCard are due to more students participating as opposed to the same participating students getting higher scores. This suggests that HyperCard involves more students regardless of learning preference.

Considering these conclusions, these hypotheses were suggested:

- Students use their whole minds in learning which requires an integration of dominant learning strengths. Categorizing students into groups based on discrete learning attributes has little meaning and could be harmful as a teaching practise.

- It is necessary to find tools that can address the needs of divergent learning styles simultaneously. Hypermedia may be such a tool but more research is required to support this conjecture.

- HyperCard has more features and is more complicated to use. Therefore more training is required to adequately use HyperCard than is required to adequately use word processing. Equivalent levels of training are required to yield clearer results.

Additionally a discussion of the changing definition of literacy due to the increasing accessibility of information due to technology, stressed the importance of developing multimedia skills for students and teachers. It was suggested that the combination of hypermedia with cooperative learning will enhance communication and learning. This, in turn, will advance the new, technology-based literacy.
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Chapter One

Introduction

Reason for the Study

A current paradigm of thinking in education and in psychology is that of constructivism. Constructivism maintains that understanding is dependent on the perspectives and preconceptions of the observer. What is learned is relative to the learner's prior knowledge and is intrinsically connected to it rather than being a quantifiable item that is merely added to existing knowledge. If children create their own realities then the act of learning must allow children to create. The computer in the classroom opens the door to huge storehouses of information, instantly available to individual students. Students learn best when they are the creators of that information. One learns when one assumes ownership of knowledge or of the process of gaining knowledge. One way of promoting this ownership is by allowing students to interact with the content of information.

If this interaction takes place then it must be on the students' terms rather than in a prefabricated presentation of information generated by an external source. Students must manipulate and discover that which is real to them in the world. Students construct their own course to discovery. Students learn in their own unique fashion. The computer is a powerful tool in the learning process but its effectiveness may well depend on the way it avails itself to the learner. If it is to match its way of offering information to every individual style of learning, then it must be a flexible, open-ended device.

Hypermedia is a computer application that presents information and allows users to create information presentations using pictures, sound, animation and interfaces to other multimedia equipment. It promotes a high degree of interactivity to students and it allows students to access information in a multi-sensory way. Another situation where this degree of interactivity and consideration for individual style occurs is when people interact with each other. Cooperative learning is the human equivalent of interactive multi-sensory learning. Many parallels can be drawn between the machine learning of hypermedia and the people learning of cooperative learning. Cooperative learners access each other's minds in a non-sequential, divergent way. They also use verbal, gestural, demonstrative and other subtle ways to communicate with each other. In other words, they communicate by using many senses. Students interact with each other according to their own unique styles to capitalize on their strengths and to circumvent weaknesses. Hypermedia provides
random access to information and a multi-sensory approach. It is both a presenter of information and a tool for the creation of new knowledge.

Hypermedia and cooperative learning are powerful teaching tools which are analogous to each other. It may be that their combination will provide opportunities for a wide variety of learners to create their own realities. The interaction between students and computers and that between students and students may be facilitated when the output of the machine can match individual input styles in a diverse group of cooperative learners. The reason for this study is to begin to research the educational value of using Hypermedia within a cooperative learning environment.

Statement of the Problem

Hypermedia and cooperative learning both allow for multiple learning preferences and for random access to information. The purpose of this study is to observe the effects of the interactiveness of non-linear computer activities on the ability of students to communicate, absorb and retain information. The role of learning preference on the ability of students to process information with the computer is also studied. This experiment examines students working cooperatively in randomly composed groups. The dominant style that each student uses to learn with the computer is assessed. How these differences in learning preferences affect learning is investigating when students use the computer in linear word processing and in non-linear hypermedia. The computer offers three modalities (visual, auditory and kinesthetic) with which users can manage information. The effects of varying degrees of interactiveness of computer activities is compared for each of two general styles of learning. The two learning preferences are based on the Seven Intelligences discussed by Dr. Howard Gardner (1989). Of these Seven Intelligences, three are skills typically addressed by the public school system. These preferences are language skills, problem solving ability and knowledge of one's self. The other four, though valuable, are often overlooked. They are the spatial, musical, kinesthetic and interpersonal abilities. Students in this study are compared according to whether their dominant learning preferences correspond to the first three of the Seven Intelligences or the last four. Two different measures were used to attempt to discriminate between these two groups of students. A computerized assessment of activity preferences was completed by the students as a self assessment. Teachers were asked to divide the class into the same two groups based on descriptors corresponding to the Seven Intelligences. A statistical analysis was done on achievement scores to determine whether more students improve after the hypermedia activities than after the word processing activities. The following questions were addressed:
• Does the computer used interactively and non-linearly, as in hypermedia, promote better assimilation of information than using the computer linearly, as in word processing?

• Does the computer used interactively and non-linearly, as in hypermedia, promote better retention of information than using the computer linearly, as in word processing?

• Does the use of hypermedia in cooperative learning with groups composed of members with heterogeneous learning preferences promote participation more than word processing activities?

• Does interactive hypermedia better meet the learning needs of more students than word processing regardless of learning preferences?

The main comparison of this study is twofold. The effectiveness of hypermedia is compared to word processing for students working in a cooperative learning environment. Hypermedia is also compared to word processing in its ability to meet the needs of all students regardless of learning preference. If hypermedia is more effective in meeting the needs of all students, more students will do well in this activity compared to the word processing activity. Cooperative learning describes the environment in which the study takes place; it is not a variable of the study. Therefore, no data are examined on individual learning situations nor can the results of this study be generalized to situations that do not use cooperative learning.

A Classroom Example

A specific example based on this author's experience may clarify how hypermedia could be used to simultaneously address the Seven Intelligences to provide a whole mind learning experience. This is based on a project that has been initiated at Simon Fraser Elementary School in Vancouver.

A cooperative group is formed to create an original story. However, the story is non-linear in nature and allows branching to different settings and events depending on the choices of the students. HyperCard on a Macintosh computer is used. The group is heterogeneous and consists of four members; ages range from five to nine. Students are encouraged to discuss ideas, to assist each other in developing ideas, to help each other with the computer, to use appropriate social skills and to vote or reach a consensus when making choices. The topic they choose for the story (unfortunately) is "The Teenage Mutant Ninja Turtles".
Part of the development of the story relies on physical exploration of the environment. They begin with a series of scanned pictures of their school including classrooms, hallways, playground, etc. As they work on each picture, they describe it so that all members are oriented. The use of the auditory modality is emphasized due to the almost total reliance on it by one group member. However, all possible modalities are incorporated. When figures in the picture are selected, by clicking with the mouse, labels "pop up" and the words are spoken with synthesized (computer generated) speech. Sounds are also recorded using a MacRecorder and incorporated into the "stack". They use speech to go with the printed story line, sound effects and music. "Buttons" are placed at key places in the pictures to link to other pictures. For instance, if they "click" on the door, they enter another room with appropriate sound and visual effects. The teacher initially helped the students program these buttons. As their skill developed, the students programmed their stacks independently.

HyperCard includes an easy to use, English-like programming language called HyperTalk. Students use the mouse and keyboard to develop their stack and navigate through it as the story emerges. Simple animation is included in some places. Each student's ideas are employed. Other resources are included such as student drawings, stories and sounds. The story is based on school experiences such as activities in the lunchroom where the lunch monitor says "Get outside!". These experiences are linked in free flowing ways to the fantasy world of the Ninja Turtles who are leaping from the storage room and yelling "Cowabunga!". There is no concrete ending to the story (although some pathways end), so ideas can continually be added in an on-going way. There is a potential in the future to incorporate video segments, dramatic performances, class presentations and sound tracks.

As you can see, all seven of Gardner's Intelligences are addressed using the three perceptual modalities that the computer can utilize. The activity is both a process and a product. All students are included and develop whole mind skills according to their individual needs in their own style. Students develop written and oral language skills and also develop social interaction skills. This is a sample of an activity that effectively uses hypermedia with relatively limited technical equipment and expertise. The potential of this recent development in the area of computer related learning is indeed exciting. With this potential comes responsibility. The creativity and sensitivity of teachers is a necessary component to successfully meet the individual needs of the whole child within an interactive multi-sensory learning environment.
Definitions

- **Cooperative learning** is a classroom structure that relies on children teaching each other according to grouping criteria and instructional goals. Many similar structures are offered by different authors. This thesis employs the structure proposed by Roger and David Johnson (1983) which allows organization of classroom groups according to the five basic elements of positive interdependence, face to face interaction, individual accountability, social skill development and group processing.

- **HyperCard** is a commercial hypermedia product for the Macintosh computer. Multi-sensory documents produced with HyperCard are called stacks. Each stack is composed of one or more cards. A card is computer screen of information presented in text, graphically, auditorily or with animation. Cards can contain buttons which when activated execute some activity specified by the stack’s author. Cards can also contain fields which are used to display textual information.

- **Hypermedia** is the use of computers and computer-related equipment in such a way that a multi-sensory presentation of information occurs. Sound, graphics, animation and text is used along with manipulation of prerecorded video and music via various electronic means. As with hypertext, students use hypermedia in a non-sequential, interactive way. The information is presented according to the wishes of the user and not in a predetermined, linear manner.

- **Hypertext** is a body of text-based information stored electronically so that information can be accessed in an order determined by the readers (Megarry, 1988). The users interact with the information according to their interests or personal goals. Each unit of information is referred to as a node and the connections between nodes are called links.

- **Intelligence** is cognitive ability and style of thinking. In this thesis, it refers to the dominant style of learning of an individual student. These learning styles are defined by Howard Gardner’s (1986) Theory of Seven Intelligences. These Seven Intelligences are linguistic, logical/mathematical, intrapersonal, spatial, musical, bodily/kinesthetic and interpersonal. Gardner further distinguishes between the first three and the last four of these Seven Intelligences. The linguistic, logical/mathematical and intrapersonal intelligences are those that are traditionally addressed by the public school system.
• The term **interactive** means a two-way flow of information. In hypermedia it refers to the non-sequential path taken by a student through a body of information. This path is determined by the preferences of the student or group of students.

• **Learning style** is a unique group of strategies, abilities and preferences that a student uses in the process of learning. The definition of learning style used here is based on the learning preferences of each student. These preferences, as employed by this thesis, are defined as a subset of Gardner's (1986) Theory of Multiple Intelligences obtained by dividing the seven intelligences into two groups. The term learning styles, as used in this thesis, refers to these learning preferences rather than a strict psychological definition based on learning theory.

• **Literacy** is normally defined as the ability to read or write (Grolier's Academic Encyclopedia, 1991). In this study, the definition includes the use of symbolic representation of ideas via electronic media.

• **Non-sequential** means a non-linear or a random access method of manipulating information. The order in which information is retrieved by electronic media is determined by the choice of the user or groups of users according to their specific purposes. In this case, users are not dependent on a predetermined order of presentation.

• **Sensory modalities** are the ways that information is transmitted from the external environment to an individual's mind. These modalities are the five senses of sight, hearing, touch, taste and smell. Only the modalities of sight, hearing and touch are considered for this research since these are the only modalities involved in computer interactions.

• **Whole mind learning** refers to a holistic view of learning in which the students' approach learning via a variety of methods, senses and perspectives. Learning is necessarily student-directed and uses a style that best suits the individual in each situation. Gardner (1986) is concerned with how the various intelligences work together in an individual learner.
Chapter Two

A Review of the Literature

This chapter presents research that pertains to the subject areas of this study:

- Hypermedia
- Cooperative Learning
- Learning Preferences
- Whole Mind Learning

Areas of research which discuss the use of computers in cooperative learning environments and the role of learning preferences in cooperative situations are also presented. Limitations of the research and possible directions for the study are discussed. The reader is prepared for a study of the use of hypermedia and the effects of learning preferences within cooperative learning computer activities.

Hypermedia

_Hypertext is high level software through which the learner explores and interacts with knowledge. Users can pursue a variety of suggested trails through the material or they can create new pathways for themselves and others to follow, by forging new links and even by extending the material. Hypertext is inherently multi-user, blurring the distinction between author, editor and reader. Hypermedia is a name sometimes given to the multi-media capability of hypertext, emphasizing the way in which users can combine, edit and orchestrate sounds, graphics, moving pictures, texts and computer software, at the click of a mouse (Megarry, 1988, p. 172)._
Hypermedia employs the same principles as does hypertext but can contain information in a variety of media including sound, music, graphics, animation, video, laser disk, CD ROM and telecommunications (E. Raker, 1989).

Properties of hypermedia relevant to a discussion of cooperative learning include associativeness, divergent paths and multi-sensory characteristics. According to Bush (1947, cited in Smith and Weiss, 1988), the human mind operates by association. Ideas and hypotheses rest on - but also hold together - its artfully composed associations of facts, insights, logic and assumptions. It defies easy transmission in bits or bytes, and is usually inextricably intertwined with individual values. (Adams, 1989, p. 12). Rather than moving from one topic or thought to the next in a predetermined, sequential manner, hypermedia allows divergent paths through information which are dependent on the associations of the user. Learning occurs through structuring new nodes and interrelating them to the existing information. (Norman, 1976 cited in Jonassen, 1988) As Raker (1989) observed, we learned to read in an artificial, sequential, linear manner in order to comply with the constraints of the printed format. However, it appears that most readers do not read sequentially. Rather, they skip from one section to another, particularly when using reference material (Smith and Weiss, 1988). Hypermedia allows non-linear movement through complex material naturally and easily. Since hypermedia combines hypertext with sound, music, animation, video and telecommunications (Raker, 1988), information can be accessed in ways that make it more meaningful (Jonassen, 1988). Therefore, a variety of different learning preferences can be addressed simultaneously. This enables students to learn in the style that is most effective for each individual. Since multiple stimuli can be manipulated in an organized and consistent way, the most appropriate mode to transfer information can be used (Tsai, 1988). For example, visual information can be presented graphically, movement information can be presented with animation and auditory oriented material can be presented with sound.

Cooperative Learning

_in cooperative learning situations there is positive interdependence among students' goal attainments; students perceive that they can reach their learning goals if and only if the other students in the learning group also reach their goals_ (Deutsch, 1962; Johnson and Johnson, 1975). Thus, students seek outcomes that are beneficial to all those with whom they are cooperatively linked. Students discuss material with each other, help one another
understand it, and encourage each other to work hard (Johnson and Johnson, 1985a, p. 8).

Salomon and Perkins (1987) state that the presence of significant others during individual or small group learning tends to increase learners' mental effort expenditure in processing information. Learners become more focused and mindful, improving both their learning and transfer of learning.

Many educators, faced with the perennial problems of overcrowded classrooms, increasingly divergent student populations, limited resources and complexity of technological advancements, are now turning to a traditionally overlooked but powerful teaching resource. The students themselves have enormous teaching potential when properly motivated and trained. Indeed, it is often the case that students are better equipped to put the material into a more easily understood language than is the teacher (Slavin, 1987).

A variety of authors (Cosden and Lieber, 1986; Johnson and Johnson, 1983; Slavin, 1987) write on the subject of cooperative learning. Roger and David Johnson, however, are the most prolific and their research has made the most impact in the schools to date. Additionally, they provide a clear structure which lends itself for application to hypermedia issues.

The Johnsons (1983) show increased achievement for students of all ages, ability levels, in all subject areas, and for all tasks involving concept attainment, verbal problem solving, categorization, spatial problem solving, retention and memory, motor performance and guessing-judging-predicting with cooperative learning techniques as opposed to the traditional methods of competitive and individual learning. Slavin (1987) reports that cooperative learning has never been found to reduce student achievement in comparison to traditional methods as long as the students are working toward some mutually valued goal and are dependent on the individual learning of all group members. In fact, cooperative learning, by the nature of its structure, promotes higher reasoning strategies and greater critical thinking competencies.

Cooperative learning is always fun (Slavin, 1987, p.9). Every human being, particularly the younger ones, have a basic interest in other people. When encouraged to work and learn with and from each other in cooperative learning groups, students have a positive attitude toward the subject and everything associated with it. The school, teacher, classmates, themselves and future expectations of learning with their peers are all regarded favorably (Johnson and Johnson, 1983; Johnson, Johnson and Maruyama, 1986). In the
competitive learning environment success is measured relative to one's classmates. One can only succeed if someone else fails. Therefore many negative perceptions of a good student can arise such as the *nerd* or *teacher's pet*. When students work toward a common goal, the same hard work which previously earned the label 'nerd' is now appreciated and valued in the same way effort is valued in team sports (Slavin, 1987). Autonomy, the ability to perceive expectations independently and then make a choice, is gained from caring and supporting relationships. Such relationships can be fostered where interpersonal interactions are encouraged, such as in cooperative learning situations. Since autonomy determines the extent to which an individual is able to make responsible, independent choices, cooperative learning can produce internalization of learning expectations and social values (Johnson and Johnson, 1985c).

Success in life is largely dependent on how well one can interact, communicate and coexist with other people. Academic knowledge or skill risk being rendered useless unless there is some way to share it with or make it meaningful to society. In cooperative learning students are directly taught the necessary social skills that a contributing adult will require. Collaborative skills which are so necessary in our multi-disciplined society are practised as an integral component of cooperative learning activities at every age and ability level. The evidence is considerable, in the research of Johnson and Johnson (1983), that cooperative learning groups master collaborative competencies better than do students working competitively or individualistically. The Johnson, Johnson and Maruyama study (1983) lists eight effects of cooperative learning that increase socialization and development:

- Promotive interaction
- Feelings of psychological acceptance
- Accurate perspective taking
- Differentiated, dynamic and realistic views of collaborators and one's self
- Psychological success
- Basic self acceptance and high self esteem
- Liking for other students
- Expectations of rewarding, pleasant and enjoyable future interactions with collaborators

Students learn to celebrate each others' successes, encourage and help each other in their work, discuss the material, enjoy the learning experience and learn to work together regardless of differences (Johnson and Johnson, 1985b).
Just putting kids together to work does not constitute cooperative learning. The researchers outline deliberate and specific guidelines for achieving success in cooperative learning groups. Students must be given good reason to be cooperative and the groups must be structured to make success in the specified task possible only when all group members contribute and learn (Slavin, 1987). Five basic elements for a successful cooperative learning structure have been identified (Johnson and Johnson, 1984):

- Positive Independence
- Face to Face Interaction
- Individual Accountability
- Collaborative and Social Skills Development
- Self-evaluation and Planning

Students must have a common goal or reward to work toward. This goal can be extrinsic, such as certificates, points, grades, etc., or it may eventually become intrinsic, that is, for the pleasure of learning itself. Since the students care about success for the whole group, it is no longer embarrassing or disallowed to ask for help from their peers. The Johnsons call this positive interdependence and it may be structured by providing mutual goals (positive goal interdependence), giving each student a specific job to do (positive role or task interdependence) or limiting resources so that they must be shared and giving the entire group a single joint reward (positive resource interdependence). Other forms of positive interdependence are also identified. Not only do group members share the responsibility for each other's learning but they are also responsible for maximizing and maintaining this learning as well as maintaining good working relationships within the group.

It must also be possible for students in a cooperative learning environment to have face to face interaction. Patterns of interaction and verbal exchanges are integral to the functioning of cooperative learning. Heterogeneous groups are preferred since a variety of backgrounds, previous knowledge, learning preferences and social styles all add to the learning of the group.

Each student must be individually accountable. It is the responsibility of the group to make sure that each member is learning the specified material and it is the responsibility of each group member to contribute to the success of the entire group. Everyone is, therefore, obliged to do his or her part. Individual accountability can be assured through random questioning, individual tests or through group self checking.
Collaborative and social skills are directly taught (Johnson and Johnson, 1985a). Some of the necessary skills include leadership, trust building, social decision making, social problem solving and encouragement techniques. These skills, which are virtually ignored in traditional approaches, are given as much educational importance as academic skills in the cooperative learning approach. In cooperative learning groups there is shared leadership rather than one appointed leader. Indeed, leadership is a social skill that is directly taught.

The teacher's task is to observe, analyze problems and give feedback to the groups. The teacher must allow for group autonomy and give them responsibility for problem solving and learning. The groups themselves, with guidance from the teacher, must process their effectiveness through self evaluation and planning for the future. This serves to internalize their social skills, making the learning intrinsically motivated and adds meaning to the activities (Johnson and Johnson, 1984).

Every successful cooperative activity must have in its structure positive interdependence, face to face interaction, individual accountability, direct teaching of collaborative and social skills, and group processing.

**Using Hypermedia with Cooperative Learning Groups**

The functional application of hypermedia in education is a relatively recent event. There is, therefore, little research upon which to draw information or to support particular practises. Although, the body of research pertaining to the use of cooperative learning is large, there is little research linking the use of hypermedia to cooperative learning.

An analogy between hypermedia and students working together is apparent. Each student in a cooperative learning group can be compared to a node of specific information. Each student is linked to others and has random access to their information via communicative and social behavior. Norman (1976, cited in Jonassen, 1988) describes learning as building new semantic structures by constructing new nodes and interrelating them with existing nodes. Learning is conceived of as the mapping of subject matter knowledge onto the learner's knowledge structure (Jonassen, 1988). New knowledge in cooperative groups, using hypermedia, could be constructed by interlinking between group members using the computer.

Within a group of learners, each member has different styles and areas of interest. Divergence is built into a learning group. Hypermedia allows divergent paths, permits
exploration and facilitates reorganization of information into more understandable formats (Jonassen, 1988). This reorganization is the same process that students perform in cooperative activities. To ensure the group's success when interdependence is present, students must translate information into the format to which each member can relate (Johnson and Johnson, 1988). An increased number of students in a learning activity means increased associations of information. Hypermedia and cooperative learning both facilitate divergent thinking (Tsai, 1988; Jonassen, 1988; Johnson and Johnson, 1988).

Smith and Weiss (1988) report that while hypertext provides greater flexibility and convenience than conventional documents, its power and appeal dramatically increase when computers are networked. Tsai (1988) describes team collaboration of knowledge networks. The team combines their knowledge by sharing the same body of information and giving and receiving comments from other team members. This knowledge system is called the Virtual Notebook and is linked to Medline, an on-line bibliographic database. Users' interest profiles can be compared with Medline citations and manipulation of stored information occurs. This capitalization on user attributes compares to the Johnson's (1988) role assignments. Positive interdependence is strengthened when students are assigned complementary roles. In both cases, each participant contributes in a unique way that reflects his or her own personal style but is an essential part of the success of the activity.

Hypermedia gives control to learners (Tsai 1988). Students determine the sequence and the content of information to suit their existing knowledge and particular learning patterns. Tsai speculates that this may improve the efficiency and effectiveness of learning. This is comparable to Johnson and Johnson's (1988) concept of heterogeneous groups. They claim that the most effective groups are the ones made up of students of various abilities, personalities and learning preferences. In a cooperative learning group, each learning preference is accommodated and because of positive interdependence, each member of the group is an essential contributor and as such controls, in some way, the direction of the group's learning. This arrangement is especially effective for complex material.

In a more practical vein, educators receive the economical benefits of using cooperative learning with hypermedia or any computer related activity. The cost of a machine capable of effective hypermedia is prohibitive to many schools. If the computer can be used in groups and still produce the expected learning outcomes, far fewer computers need to be purchased. Indeed, the research of Johnson and Johnson (1988) indicates that cooperative group work at the computer is more productive than the individualized use of the computer. As Smith and Weiss (1988) discuss, networked computers improve the use of hypertext.
Cooperative Learning Structure with Computers

The Johnsons (1983) identify three types of learning: Competitive, Individual and Cooperative. Competitive learning is the most common in the classroom. Success is determined by comparison to the work of classmates. Therefore there must be winners and losers, and success is possible only when others fail. Often ability is the factor that determines success but many times it is a case of compatibility between learner preference and the presentation of material. In Individual learning, success is not related to the success of classmates. Interactions are discouraged and social skills are not practised. This type of learning, although prevalent when teaching all students, is especially utilized when teaching students with special needs or students with widely divergent styles of learning. Cooperative learning is dependent on interpersonal interactions and is structured according to the five basic elements of which social skill development is an essential component. Students can be successful only when all group members are successful, regardless of ability or learning preference.

It is the interaction patterns and verbal interchange among students promoted by positive interdependence that affect education outcomes (Johnson and Johnson, 1984, p. 1:10). According to the Johnsons (1988) and Lehman (1985), the educational use of the computer often occurs in an individual learning environment with one student per computer. The social isolation involved in a strict individual learning situation can produce negative mood states in many students. These include loneliness, boredom or frustration (Johnson and Johnson, 1986) and interfere with sustained effort to complete learning tasks. By contrast, having students working collaboratively creates positive mood states and increases students' motivation to achieve. In the cooperative situation, students are required to summarize and explain orally what they are learning. There is evidence that these discussions result in higher level cognitive reasoning, increased achievement and increased retention. Computers by themselves cannot provide social models which are so powerful for the teaching of learning skills and strategies (Johnson and Johnson, 1986). Additionally, social reinforcement is stronger than reinforcement given by computers. There is evidence that students prefer to work cooperatively (Muller and Perlman, 1985; cited in Johnson and Johnson, 1986). Observation of students at an electronic arcade or playing computer games at home shows that the informal use of the computer tends to produce social interactions (Hawkins, Sheingold, Gearhart and Berger, 1982; cited in Johnson and Johnson, 1986). Students are less likely to participate in these activities by themselves. The computer has a very public display which attracts groups of students and also motivates them to interact with the computer together. Since students tend to seek
each other out when at the computer more than with other kinds of school work, the computer is a good place for cooperative learning (Johnson and Johnson, 1988).

Descriptions are given of the learner-directedness of hypermedia (Tsai, 1988; Jonassen, 1988) and of cooperative learning (Johnson and Johnson, 1983). Tsai (1988) also presents a dilemma. While the greater degree of learner control improves the efficiency and effectiveness of learning by accommodating individual differences, there are also negative effects on learning for many students since learner control without guidance has been shown to be ineffective. Learners may not know what sequence or contents are necessary or they may not act upon the knowledge they possess. Decisions in a cooperative group are made with input from all members. Choices are made democratically. Consensus can often be reached in small groups or disagreements can be resolved fairly through debate and voting. The teacher acts as a consultant or guide without directly controlling the activity (Johnson and Johnson, 1985a). In this way, learner control is maintained. *We want our students to explore information freely and easily, but with purpose and discipline* (Marchionini, 1988, p. 12).

Three models of computer use have been discussed by Jonassen (1988), Tsai (1988) and Lehman (1985). Lehman identifies ways of using the computer as being a presenter of information, a tool and an object of instruction. Hypermedia can be thought of as a vehicle for all three of these models. Tsai (1988) predicts that hypermedia will find major areas of application in instruction (presenter), electronic publishing and on line database (tool) and thinking and authoring tools (object of instruction). Jonassen (1988), referring to the use of hypertext, states that learners should be encouraged to access information (presenter), explore it (tool) and even alter it (object of instruction).

The Johnsons (1988) give three examples of using cooperative learning effectively across these three models by applying their five basic elements of cooperative learning. Positive interdependence is established by assigning different roles and tasks to the participants at the computer (keyboader, explainer, checker, recorder, etc.). All group members must share resources since there is just one computer. The final product of the activity is shared whether it be information, a high score or a printout. Face to face interaction occurs when students reach agreements, explain information, clarify results or whenever communication takes place. Indeed, the computer stimulates on-task, enthusiastic discussions. Individual accountability is ensured through individual testing, random questioning or group self evaluation. If one member of the group has not mastered the criteria of the exercise, then the entire group has not yet finished due to positive interdependence. Social skills are directly taught for use at the computer. Skills, such as negotiation, encouragement, turn
taking, etc., are modelled and rehearsed before the activity. Finally, group processing takes place at the end of the activity. The participants evaluate how well they function and make plans for improvement in future activities. This promotes ownership of the learning and behavior and internalizes the academic and social lessons learned. Johnson and Johnson (1985a) believe that computer activities based on this structure produce similar results including greater achievement and retention, increased motivation, increased higher level reasoning skills, more positive attitudes, greater self esteem and improved collaborative skills.

Heterogeneous groups of three seem to work best. Any activity can be structured as a cooperative learning activity and may only include the computer for part of that activity (Johnson and Johnson, 1988). Hypermedia's flexibility allows it to be used in a variety of ways which can be determined by the teacher or by students. Products are available that allow for hypermedia program or stack design. Some of these are HyperCard or SuperCard for the Macintosh, Guide or IBM Linkway for MS DOS machines, Tutor Tech or HyperStudio for the Apple][gs and Cando or AmigaVision for the Amiga. With these programs, non-programmers can design or customize stacks for their own educational purpose (Raker, 1989). Teachers are able to design a cooperative computer activity without being dependent on the availability of appropriate commercial software.

With this type of tool, teachers who are familiar with computer applications yet have no programming experience are able to customize their information to fit an individual lesson, thereby exerting some control over computer-enhanced curricula. Hypertext-driven programs allow for individual styles and interpretations, which will keep the information dynamic (Harris and Cady, 1988, p. 33).

Landow (1989) describes the hypertext-based Intermedia where students collaborate to build a knowledge base. They are able to read and respond to each other's papers. This is similar to Tsai's (1988) dynamic database which is networked to capture and provide comments and enrichments from the whole user population. These activities parallel the work of students using HyperCard in many British Columbian elementary schools. For example, at Marigold Elementary School in Victoria, students collaborate to produce stacks on a common theme, such as whales. Each student does part of the research and adds that part to the common stack. Graphics, animation, digitized sounds, textual information and backgrounds of the authors are included in the final student produced collaborative stack. This activity requires positive interdependence, interpersonal interactions, individual accountability, social skill development and self evaluation. It is a working example of the
cooperative use of hypermedia as an information presenter, a tool and an object of instruction (Allen, D., 1988).

*The technology of computers and the interpersonal interaction promoted by cooperative learning provide complementary strengths. It is a partnership that maximizes the advantages of each instructional strategy* (Johnson and Johnson, 1985a, p. 20).

**Limitations of Using Cooperative Learning and Hypermedia**

The authors also discuss areas that may present limitations or difficulties to the cooperative learning-hypermedia strategy.

Johnson and Johnson (1988) claim that the most common use of the computer for students is individual. That is the most easily applied use of the computer in the busy classroom. Hypermedia's multiple stimuli approach can meet individual needs rather than linking students together to develop an appreciation of differences and enriching thinking styles. This is the simplest approach, particularly for those students with very different learning styles. Teachers can take advantage of hypermedia to teach according to the most likely sensory input for an individual without the distraction of a multiplicity of other people and styles.

*Users (readers) of hypermedia are freed from the linear, highly directed flow of printed text. They are encouraged to browse a hyperdocument, move easily among vast quantities of information according to plan or serendipity, follow relationships precoordinated by the author or create their own paths through the information* (Marchionini, 1988, p. 8).

Raker (1989) observes that we have learned to read in a sequential, linear manner. Random accessing may not be the most comfortable way for many students to retrieve information. A common concern for the hypermedia environment is user disorientation (Tsai, 1988). Hypermedia structures are network-like and more complex than printed documents. The map of nodes and lines of interactions may become too complicated to understand and readers may be lost in the tangle. The dynamic nature of hypermedia further complicates matters by continually changing the content of the structures.

Jonassen (1988) asks how much structure is appropriate or what kind of structure is best. There is a need for clear structure for students to make effective use of hypermedia but there is also a desire to maintain open-endedness for students to pursue their interests and
to allow for individual styles (Tsai, 1988). Since it has been determined that learner control without guidance is ineffective, the degree of navigational guidance must be determined (Jonassen, 1988). It is also yet to be determined how a cooperative learning structure can be used to establish freedom of choice while providing clear guidance.

One of the advantages of using hypermedia is to allow student-directed learning (Tsai, 1988). The dream of creating information-rich learner-directed instructional environments is becoming a reality (Morariu, 1988, p. 17). This is also an advantage of using cooperative learning. Students in cooperative groups tend to address far fewer remarks to the teacher than to each other (Johnson, Johnson and Stanne, 1986). The problem with student-directed learning, although the clear benefits were discussed, is in evaluating this learning. If the students determine the goals of their learning it may not be fair to apply the teacher's standards of success. If the teacher does set the criteria for the learning outcome then student-directed learning is not complete since they do not have complete control. Yet evaluation is an integral part of the school system and society must be assured that all students learn a common body of skills, concepts and principles (Marchionini, 1988; Morariu, 1988).

Smith and Weiss (1988) discuss the problem of intellectual ownership. With many contributors to a hypermedia project, individual ownership of the parts becomes blurred. Johnson and Johnson (1985c) organize cooperative groups to share ownership as a component of positive interdependence. Still, the Johnsons recognize that there is a place for individual learning and therefore, individual ownership of projects (Johnson and Johnson, 1989). Individual contributions may be an important part of a large project. One cooperative concept is that of jigsawing, where each member is responsible for an essential part of a project. Certainly concepts acquired individually gain meaning and usefulness when shared with a group. The role of these individual components and the concept of ownership must be developed further (Kearsley, 1988).

The computer can be distracting. Hypermedia, in particular, with its richness of presentation, makes cognitive demands that some students may not be able to meet (Dede, 1988; cited in Jonassen, 1988). Navigational decisions may divert learners away from the content of their learning (Marchionini, 1988). The Johnsons (1986) recommend that students meet away from the distracting computer for planning and solving certain problems. There may be strategies that need to be defined to focus students on the process of learning and interactions using the computer as a transparent tool or a means to an end rather than the focus of attention.
The greatest limitation is a temporary one. The newness of hypermedia technology has not
given researchers the opportunity to make detailed investigations of its use in education.
There is much promise in combining its use with cooperative learning strategies.
Obstacles to this application were outlined but there is not yet a body of research to
suggest solutions or alternatives. Some authors, however, outline directions that they
believe the research should take.

**Research Directions**

Much discussion centers around attempting to discover the optimum structure of
hypermedia and classifying prominent paths according to learner preferences. Alternately,
he suggests imposing structures and assessing the effects of these structures on recall.
These approaches may provide information about differences in the knowledge structures
of learners exploring structured and unstructured hypertext. Tsai (1988) outlines the need
to determine the proper balance between learner control and structured guidance. In the
cooperative learning situation, one expects less structure to be more tolerated and more
compatible with divergent thinking processes (Johnson and Johnson, 1988).

Tsai (1988) suggests research to confirm or refute the notion that high ability students
learn well from unstructured hypermedia but prefer more structure and, conversely, that
low ability students learn well from increased structure but enjoy non-structured
hypermedia design. It is of further interest to apply cooperative learning techniques to see
if the positive interdependence of group members and increased tolerance for learner
preference and ability increases learning and enjoyment for both groups as predicted by
the research of Johnson and Johnson (1988) for computer assisted instruction.

Hypermedia provides the ability to match learner preference to the appropriate structure
(Jonassen, 1988). Research is needed to determine the optimum way of integrating the
multiple knowledge bases of a variety of students working in a group. Can hypermedia be
truly democratic by meeting the needs of all students in a group with its multiple sensory
ability rather than meeting only the needs of the majority or the strongest? Social factors
in cooperative learning must be researched and integrated with the appropriate technical
factors of hypermedia (Marchionini, 1988).

Hypermedia, as an intelligent tutor which can find gaps in a student's knowledge and fill
them by accessing the relevant knowledge bases, was described by Jonassen (1988). This
ability meets the criteria of being an aid for individual accountability in cooperative learning. Students can use hypermedia to determine the knowledge gaps in their group and again use hypermedia to fill those gaps with the assistance of peer tutoring as described by the Johnsons (1986).

The use of networking in hypertext is discussed by several authors (Jonassen, 1988; Tsai, 1988; Kearsley, 1988). Since networking is a method of linking individuals to each other by communicating over distances, the application to cooperative learning is clear. This adds an interesting dimension to the cooperative learning literature, investigating useful structures of electronically linked cooperative learning groups.

**Hypermedia and Learning Style**

> How each individual learns is a function not only of chronological age, but also of personal interests and abilities, preferred ways of learning, the learning opportunities and experiences which that individual has had in the past, and the characteristics of the current learning environment (The Ministry of Education, Province of British Columbia, 1990, p. 8).

Hypermedia and hypermedia-related products are now abundantly available to teachers. Their addition to the school environment allows for a student-driven approach to non-linear access of information (Smith and Weiss, 1988). Ideas are pursued by individual students or groups of students based on associations according to their interests (Jonassen, 1988). The process of learning is emphasized since relationships between ideas are understood, making the content of the knowledge more meaningful (Marchionini, 1988). Additionally, hypermedia allows for the use of multi-sensory presentations. Graphics, sound, animation, video, CD ROM, etc. are all available for interactive use by students and teachers (Raker, 1988). In the past, computer activities were visual, text based, one way, linear presentations of information. Students can now learn according to their own unique style in an interactive way. Teachers can readily design their own hypermedia material without the need for extensive programming experience in a fraction of the time that was required to produce conventional software. While this allows for a myriad of highly motivating, educationally sound computer learning materials, it also opens the door for the production of inappropriate, poorly designed products (Kearsley, 1988). We must recall the advent of educational software. It was mostly a visually based, sequential presentation of facts, requiring little creativity on the part of the student. Since these products were designed by programmers, they were generally technically sound but educationally suspect (McCabe, 1983).
Every student has a unique style of learning. At the perceptual level, the computer offers interaction by three different sensory modalities: visual, auditory and kinesthetic. Students generally favor one modality over the others but a combination of two or all three are often used depending on learning preference, type of activity, environment, mood, etc. Contrary to the pioneer efforts in educational software, which were visually based, hypermedia offers information across all three modalities. Multi-sensory computer uses meet the needs of all students (McCabe, 1983). McCabe (1983) gives some examples of the use of perceptual modalities in software design. A kinesthetic learner needs the opportunity to type and use repetition of actions. An auditory learner responds to sounds and song patterns. A display devoid of clutter and which uses color to emphasize points assists visual learners.

Since hypermedia uses text, sound, music, animation, video and telecommunications (Raker, 1988), information can be accessed in ways that make it more meaningful (Jonassen, 1988). Therefore, a variety of different learning preferences can be addressed simultaneously. This enables students to learn in the style that is most effective for each individual. Since multiple stimuli can be manipulated in an organized and consistent way, the most appropriate mode to transfer information can be used (Tsai, 1988). For example, visual information can be presented graphically, movement information can be presented with animation and auditory oriented material can be presented with sound.

Visual, auditory and kinesthetic (psychomotor or tactile) are the modalities that can be incorporated and controlled in the presentation of information within a hypermedia environment. The use of all sensory modalities is required to produce multi-sensory programs that will assist all students to learn... (McCabe, 1983, p. 531). The way that students perceive, interact with and respond to the learning environment are referred to as the student's learning style (Keefe, 1987). In other words, the three sensory modalities are the tools used to provide information with which students interact according to their own unique learning style. So it is not enough to merely concern ourselves with visual, auditory and kinesthetic presentations, we must also consider the content and strategies in the organization of the hypermedia environment. Thornburg (1989) cautions against linking the senses directly with learning styles. For example, animation invokes vicarious kinesthetic information through visual displays; listening to music may elicit visual imagery.

There are several conceptions of learning styles in the literature. Some refer only to perceptual styles, some refer to cognitive styles and others refer to personality traits. Keefe (1987) has compiled a comprehensive list of learning styles organized around three basic
categories. Cognitive style refers to information processing habits that include perceptual modality preferences, field dependence versus field independence and scanning. Affective style refers to motivationally based processes such as curiosity, level of anxiety, frustration and tolerance. Physiological style refers to biologically based responses including health related behavior, time of day and environmental elements. In all, Keefe has identified some thirty two separate elements of learning styles across the three categories.

Anthony F. Gregorc (cited in Keefe, 1982) describes a cognitive styles model based on patterns of thinking from concrete to abstract and random to sequential. So individual styles are made up of varying proportions of the four combinations of concrete-sequential, abstract-random, abstract-sequential and concrete-random. These and other models prove to be useful in identifying learning styles of students. One must be careful not to apply these models in an effort to categorize students and prejudge their abilities but to use them as a measure of strengths to use in teaching. As one could surmise by the large number of scales and criteria for learning style evaluation, these measures and categories are largely arbitrary and used as a frame of reference in designing and selecting materials and methods to assist students in their learning. *Intelligence is basically a pluralistic concept* (Gardner, 1986,p. 27).

Multiple Intelligences

An intelligence is an ability to solve a problem or to fashion a product which is valued in one or more cultural settings (Gardner, 1986, p. 25). Howard Gardner (1987) developed a paradigm for conceptualizing learning styles. He refers to these classifications of learner styles as his theory of multiple intelligences. *Our minds and our brains are composed of different modules, and it is difficult to get transfer from one module to another* (Gardner, 1986, p. 27). The Seven Intelligences are:

- Linguistic
- Logical/Mathematical
- Intrapersonal
- Spatial
- Musical
- Bodily/Kinesthetic
- Interpersonal
In the past, classrooms focused mainly on the first three of these learning styles, linguistic, logical/mathematical and intrapersonal, and virtually ignored the others (Thornburg, 1989). This approach missed the children whose dominant styles are one of the other four and also missed the opportunity to develop the other four intelligences in all children. Now, with many educators' commitment to teach to the whole child (Miller and Seller, 1989; The Ministry of Education, 1990), all seven styles of learning must be considered in every child. David Thornburg (1989) gives examples of the use of the computer as it applies to each of these classifications. Uses of hypermedia are also considered for each of the Seven Intelligences.

The first intelligence, linguistic, refers to the use of language and words. Many traditional educational software packages rely on the presentation and input of text as its primary vehicle of instruction. Word processors and language based drill and practise programs, such as spelling drills, are examples. Gardner, in describing a linguistic style of personality, recalls Robert Lowell. *He would pick out a particular word in the poem and ... tell you how every major poet in the English language had used that word over the centuries* (Gardner, 1986, p. 28). This, though an incredible feat, is exactly how hypertext functions. Each idea or word in a unit of information can be linked to other volumes of information with which it is associated. The Lowell example could readily be replicated, if the volume of literature needed was in some form of electronic storage such as CD ROM. The student would "click on" or in some way select the word in a presented poem. The student could then seek other uses of the word in the literature and make associations.

The second intelligence is logical/mathematical. This is the kind of intelligence possessed by logicians, mathematicians and scientists. It is Gardner's contention that this was the kind of intelligence that Piaget was studying and that it is the type of intelligence tested by standardized testing and IQ tests. There is a high correlation between this intelligence and performance in school and in writing tests. There is, however, no correlation between this intelligence and cognitive performance or *effectiveness of behavior*. Still, this is a valued intelligence in our society and students who do well in academic subjects are apt to be well placed professionally. Therefore, many software products address problem solving. There are many adventure games being produced which require logical thought to solve them. Hangman type games and mazes are also plentiful in the educational software world. The use of this type of intelligence in hypermedia may firstly be realized in programming. It is important to realize that hypermedia, while considered an interactive product, can also be considered an evolving product that changes as students interact with it. It is a process as well as a product. These logical/mathematical students may be the ones who are interested
in developing hypermedia projects since the hypertext language is very English-like, allowing for easy application of programming and problem solving skills without having to manage a semantically and syntactically confusing computer language. These projects can be used meaningfully, relating to the students' interests. Navigation, through complicated webs of links in hypermedia, is also a practical use for this type of thinking style. Additionally, the adventure game style of software is easily designed in hypermedia. It is a natural environment for exploration and problem solving. With the addition of graphics, animation and sound, the motivation inherent in these products is greatly enhanced.

Intrapersonal intelligence refers to the ability to know one's self and to use that knowledge effectively to meet one's needs. Individual learning is the most common method of using the computer. Indeed, most computer software is designed with a solitary user in mind. An example of intrapersonal use of the computer is computerized personality inventories. Hypermedia is more open-ended and often relies on the contributions of several people to a body of knowledge. However, the way a hypermedia product is used is up to the teacher or student. Solo navigation through a body of knowledge is also a productive use of hypermedia.

The next four intelligences are those that have often been overlooked in the traditional school system but which in light of a holistic curriculum must be considered equally important.

Spatial intelligence is the ability to form a mental representation of the world. Painters, sculptors, architects, surgeons and sailors are some examples given by Gardner as people with spatial intelligence. Paint programs abound along with computer assisted design (CAD) software. Simulation programs assist students in areas from pilot training to dissection. Spatial thinking is magnified with hypermedia. Graphics and animation are readily available but so is the power of video. Massive stores of images, both still and moving, are instantly displayed according to the wishes of the user. For example, a student can explore classical art in order of common properties or by following a thread of associations. Written information is displayed at the same time. Art can be studied according to student needs and displayed visually, which is the most meaningful mode. The graphical method of presenting information overcomes the difficulties that many students experience accessing information in a linguistic based approach.

The musical intelligence is typified by Bernstein and Mozart. A variety of music programs are available for the computer along with MIDI devices. This is a standard musical interface for computers which allows for the interconnection of instruments and computers
to allow students to easily experiment and express themselves musically. With its capacity for interconnectivity, hypermedia provides an environment for MIDI activities. Additionally, sound can be included in hypermedia products. Hypermedia can be used to access music or sounds that are stored on a laser disc. These sounds can be accessed randomly, according to student needs, rather than sequentially as in standard musical devices such as records or tapes.

The bodily/kinesthetic intelligence is the ability to use your whole body, or part of your body, to solve a problem or fashion a product (Gardner, 1986, p. 28). Dancers, choreographers, athletes and surgeons are examples of people with bodily/kinesthetic intelligence. Providing input to a computer is no longer restricted only to the keyboard. There are mice, graphics tablets, joysticks, touch screens, even floor mats that children can jump on to give input to the computer. An experimental field of study is that of virtual reality. It is now possible for users, wearing a variety of sensors and feedback devices, including goggles, headphones, power gloves, and microphones to enter a computer simulated world that responds to their movements in a way that matches the real world. Students can now explore alien planets, enter fantasy worlds or explore historical events in person. Hypermedia is the most likely environment for this type of virtual reality to develop. Imagine a virtual house with several rooms. Each room is a node similar to nodes of information in hypertext. Each node or room is connected via hypermedia links. The links are activated by physical movements. One could walk across a room, open a door and enter another room. All of the information to create this virtual house is contained within a hypermedia-based computer.

Gardner distinguishes between the two personal intelligences, intrapersonal and interpersonal. He speculates that although they both are difficult to understand and to measure, they may be the most important of the Seven Intelligences. Interpersonal intelligence is the ability to understand other people. Salesmen, politicians, teachers and clergymen are high in interpersonal intelligence. As mentioned earlier, computers are often used individually which denies learners the opportunity to utilize and develop their interpersonal skills. However, some uses are increasingly oriented to interaction between people. Telecommunications link people across distances and allows the exchange of information in text, graphic and sound format. Local area networks (LANs) offer this same ability to exchange data within a small area such as the workplace or a school. The motivational qualities of the computer and the increasing sophistication of technical peripherals encourage students to work together in small groups at the computer. The use of cooperative learning with groups of students using a computer has shown gains in interpersonal skill development. The public nature of the screen permits the students to
learn from each other by watching how another student solves problems (Cosden and Lieber, 1986). Students working in groups, consistently use each other as resources (Lieber and Semmel, 1986; cited in Cosden and Lieber, 1986). They ask questions, give answers and explanations, help with pacing and remind each other to continue working. Research shows that the benefits of cooperative learning apply to computer related activities in the same way as it does to non-computer related learning structures (Johnson and Johnson, 1981). Specifically, students working in cooperative groups show cognitive gains in problem solving, concept attainment and group productivity (Cosden and Lieber, 1986). Studies of social behavior with computer instruction find that students tend to interact positively, exchanging more task related comments than during other types of instructional activities (Hawkins, Steingold, Gearhart and Berger, 1982; cited in Johnson et al, 1986). Computers enhance on-task social interactions. These types of on-task, spontaneous interactions do not occur as frequently with other types of academic activity. Students working cooperatively with the computer address far fewer remarks to the teacher and more remarks to each other than students working individually or competitively. These interactions are task oriented. (Johnson, Johnson and Stanne, 1986). Students need social models to imitate and to use for social comparison. Computers cannot provide these social models, making cooperative computer activities even more valuable (Johnson and Johnson, 1985a). The approval and warm interactions of classmates are much more reinforcing than the cold, objective responses of a computer program. Computer feedback is literal and dependent on the keypresses of the student. Peers, however, can diagnose, correct and give complex, complete feedback. Working with peers also promotes divergent thinking and creativity (Johnson and Johnson, 1985c). Activities have been described (Tsai, 1988; Smith and Weiss, 1988; Kearsley, 1988) for using hypermedia that depend on collaboration. The teaching of collaborative skills within a cooperative hypermedia activity enhances the learning outcomes of that activity. Since hypermedia tends to be a communication-enhancing device that links people together as well as information, skill in collaboration is desirable. Hypermedia employs a rich multi-sensory environment which promotes interactions between people through a variety of modalities, allowing for communication without necessarily requiring a high degree of linguistic intelligence.

_He [Gardner] concluded that we all have at least seven intelligences: linguistic, logical/mathematical, intrapersonal, spatial, musical, bodily/kinaesthetic, and interpersonal. Each of us excel in one of these areas, but we all have capabilities in the other six_ (Thornburg, 1989, p. 120).
The Whole Mind

*From the holistic perspective learning is the active construction of meaning by persons, the understanding of a whole, a process that is in some way different from learning a series of parts or elements* (Berlak and Berlak, 1981, p.151; cited in Miller and Seller, 1990, p. 10).

*The focus of holistic education is on relationships... In the holistic curriculum the student examines these relationships so that he/she gains both an awareness of them and the skills necessary to transform the relationships where it is appropriate* (Miller, 1988, p. 3).

*In any ordinary form of activity you have numbers of intelligences working together, but they work together in unpredictable ways. ...if you look at us carefully, you will find very few of have exactly the same level or configuration of intelligences* (Gardner, 1986, p. 29).

*Some programs will enhance a child's dominant skills through his or her dominant intelligence; some will develop his or her nondominant skills through the dominant intelligence* (Thornburg, 1989, p. 120).

The computer can be used as a tool to assist the learning of students with dominance in each of Gardner's Seven Intelligences. Hypermedia is the learning environment of choice to easily incorporate strategies for addressing these intelligences. But one must be careful to address all learning styles with each student. Although we all may have dominance in one or more areas, all areas play a role in learning and in interacting with our environment. No one area can effectively contend with a diverse learning environment. To divide the mind into Seven Intelligences is somewhat contrived for the sake of understanding learning style. *The Seven Intelligences are really for illustrative purposes* (Gardner, 1986, p. 27). As we have seen, many such schemes have been devised based on various criteria. In fact, each intelligence or learning style overlaps with each of the others. *The structure of a fugue may be seen as geometric; the sight of a meadow filled with flowers may evoke a favorite piece of music in someone's mind* (Thornburg, 1989, p. 120). So to consider the various parts that make up the mind or the many learning styles is useful only in helping us understand how to teach to the whole mind. Thornburg (1989) advocates the bringing together of technical equipment into a workstation so that music, graphics, video, massive libraries and powerful software is under the control of a single keyboard. This is what hypermedia accomplishes.
Conclusion

From the literature review one expects the following learning outcomes:

- Greater Achievement
- Greater Retention
- Benefits for a Greater Range of Students
- Enhanced Communication
- Positive Attitudes
- More On-task Behavior

Greater achievement and retention is a central claim of proponents of cooperative learning (Johnson and Johnson, 1988) and the authors of the hypermedia literature (Marchionini, 1988; Tsai, 1988; Jonassen, 1989). Since hypermedia presents information in a way to reach students with multiple styles of learning and divergent ways of thinking, it is expected that increased achievement benefits a greater range of students when combined with cooperative learning.

Social skill development is another outcome of cooperative learning (Johnson, Johnson and Stanne, 1986). Of particular interest is the development of communication skills since students must interact with each other to succeed in a cooperative situation. Students using hypermedia are communicating as they receive information or send messages. Of special interest is the way in which communication takes place along many pathways because of the multi-sensory presentation of information. It is expected that communication is enhanced when hypermedia is used in cooperative learning.

Collaborative skills are necessarily enhanced in cooperative learning. These skills are directly taught to participating students to ensure the success of the collaboration (Johnson and Johnson, 1986). Activities were described for using hypermedia that depend on collaboration (Tsai, 1988; Smith and Weiss, 1988; Kearsley, 1988). The teaching of collaborative skills within a cooperative hypermedia activity is expected to enhance the learning outcomes of that activity. As previously noted, hypermedia tends to be a communication-enhancing device that links people as well as information, skill in collaboration is desirable.

The use of cooperative learning is found to result in more positive attitudes of students in relation to their school, subject material and instructors (Johnson and Johnson, 1988). The
use of the computer as an instructional aid is generally met with enthusiasm. When students are allowed to explore and build their own information environment according to personal relevance, interests and needs of the users, attitudes again are improved (Jonassen, 1988). Attitudes toward classmates, regardless of handicap, gender, ethnic background or ability, are also improved in the cooperative situation (Johnson and Johnson, 1988). The use of hypermedia across varied learner styles was discussed. It is expected that when students possessing the various differences just mentioned work in a group at the computer, where hypermedia and cooperative learning allow them to be successful, their attitudes toward each other will become very positive. This is reflected in increased participation.

The literature suggests that both hypermedia and cooperative learning offer enhanced learning to students, particularly in the areas of improved communication, accommodation of multiple learning styles, increased divergent and complex thinking skills, improved collaborative skills and ease of information access. It seems logical to combine the two areas of instruction. The social interaction complements the technology and results in better learning. However, there is a dearth of research on the subject. Based on suggestions from the authors studied and on conjecture from comparisons of their work, research directions have been outlined. These include finding effective structures for cooperative hypermedia activities, discovering the nature of communication within computer groups, observing social interaction and determining appropriate types of activities. This study begins the pursuit toward enlightenment in these issues.
Chapter Three
Methodology

This experiment compared hypermedia activities to word processing as a tool for students for recording and communicating information. Students were assessed after they used either hypermedia or word processing to compile information on a classroom presentation. These students were assessed for achievement, retention and participation. Student performance was also compared across learning preferences within the two media. Answers to the following four questions were sought:

- Do hypermedia-based learning activities promote higher achievement than word processing-based learning activities as measured by a content-based test?

- Does hypermedia promote higher retention of information as measured by the same test administered two weeks after the activities?

- Do hypermedia activities promote greater participation as observed by the teacher during the activities? Teachers make observations according to predetermined criteria.

- Does hypermedia accommodate diverse learning preferences? Hypermedia is judged to be effective across learning preferences if there is greater achievement and retention for more students regardless of learning preference.

Dependent Variables

There are three dependent variables:

- Achievement
- Retention
- Participation

Four primary classes in the Vancouver Lower Mainland area were participants in the study. A presentation was made to the classes on the topic of The Five Senses. A pre-test on the chosen topic was given to each class involved in the study. This established a base line for comparison of increase in knowledge of the topic. It also established equivalence between the different classes. An audio-visual presentation (Appendix D) of this topic was then made to the classes. The students worked in cooperative groups of three to produce their own computer version of the information that was communicated to them. Two of the
classes used a hypermedia activity to make their presentations while the other two classes used a word processing activity. After the activity, students were tested to measure the increase in knowledge of the content area. After two weeks the students were tested again to measure retention. The same test was used as the pretest, achievement test and retention test. The test was computer based (Appendix F). This allowed the students to take the test independently with minimal intervention from the experimenter. The test questions were presented with sound, pictures and text so that they were more readily understood by pre-literate students. Achievement was measured by comparing the pre-test scores and the scores of the post-test. Retention was measured by comparing the pre-test scores and the scores of the test taken two weeks after the activities.

At arbitrary points during the activity, students chosen randomly were observed for one minute intervals. Time on and time off task was measured during this interval. Time on-task was constituted by discussion, gesturing or intentness on the computer or group mates. This served as a measure for participation and on-task behavior.

The activities were then switched between the classes and repeated with The Sense of Sight as a new topic. The HyperCard groups then participated in the word processing activity and the word processing groups then participated in the HyperCard activity.

**Independent Variables**

There are three independent variables:

- Hypermedia activity
- Word processing activity
- Learning preference

The hypermedia activity took place in cooperative groups of three using HyperCard on a Macintosh computer. Students developed a presentation based on material to which the class had been exposed prior to the activity and supplemental material was supplied by the experimenter. Students could use a library of graphics and sounds or could create original resources on the computer. Teachers could assist the students on the technical aspects of stack construction but the ideas for content and design was entirely student generated. Students did, however, have an understanding of what a HyperCard stack is and were familiar with the possibilities available to this medium.

The word processing activity took place in cooperative groups of three using Microsoft Works on a Macintosh computer. Students developed a presentation based on material to
which the class had been exposed prior to the activity and supplemental material was supplied by the experimenter. Students could utilize a library of graphics or could create original resources on the computer. Teachers could assist the students on the technical aspects of word processing but the ideas for content and page design were entirely student generated. Students did, however, have an understanding of what word processing document is and were familiar with the possibilities available to this medium.

Table 3.1 indicates the features and properties of word processing and HyperCard pertinent to this experiment:

<table>
<thead>
<tr>
<th>Word Processing</th>
<th>HyperCard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text Input Via Keyboard</td>
<td>Text Input Via Keyboard</td>
</tr>
<tr>
<td>Mouse Control of Editing</td>
<td>Mouse Control of Editing</td>
</tr>
<tr>
<td>Graphics Importing</td>
<td>Graphics Importing</td>
</tr>
<tr>
<td>Drawing Tools</td>
<td>Drawing Tools</td>
</tr>
<tr>
<td>Linear Presentation of Information</td>
<td>Interactive Access to Information</td>
</tr>
<tr>
<td>Minimal Training Required</td>
<td>Substantial Training Required</td>
</tr>
<tr>
<td>Flexible Mixing of Text and Graphics</td>
<td>Sound</td>
</tr>
<tr>
<td></td>
<td>Animation</td>
</tr>
<tr>
<td></td>
<td>Visual Effects</td>
</tr>
<tr>
<td></td>
<td>Icons</td>
</tr>
<tr>
<td></td>
<td>Programming Option</td>
</tr>
</tbody>
</table>
At the beginning and end of the study, students were assessed to determine which learning preference was dominant. Gardner (1986) states that traditionally schools have primarily addressed the needs of students whose learning styles are:

- Linguistic
- Logical/Mathematical
- Intrapersonal

Traditionally schools have virtually ignored the learning styles of:

- Bodily/Kinesthetic
- Spatial
- Musical
- Interpersonal (Thornburg, 1989).

Measures in this study defined two learning preferences based on the Seven Intelligences. The population was dichotomized into two very broad categories. The important consideration in the definition was the difference between the groups rather than the accuracy of identification of attributes of each of the groups. The study was interested in discovering which computer activity best met the learning needs of students with diverse learning preferences. The first group was considered to be composed of students who had dominant strengths in the first three of Gardner's Seven Intelligences (linguistic, logical/mathematical and intrapersonal). The second group was considered to be composed of students who had dominant strengths in the last four of Gardner's Seven Intelligences (bodily/kinesthetic, spatial, musical and interpersonal). Dividing students into only two groups increased the likelihood of identification of two different types of learners. It is easier to distinguish between two groups than it is to identify seven styles with the specific learning environment used in this study. The perceptions of teachers was thought to be the most reliable measure of learning preference available. The teachers had worked with their students for at least eight months and, as is required by their jobs, had formed a profile of how it is that each of their students learned best. In order to translate these profiles into the terms of this study, the teachers were asked to assign each of their students to one of two categories based on descriptors from either the first three of Gardner's Seven Intelligences or from the last four (Appendix A). An alternate assessment was also made by the classroom aide or by a teaching partner.
Students in this study were also asked to report their preferences of activities based on the Seven Intelligences. Students were presented individually with a HyperCard stack (Appendix E) that offered several choices between two activities. One activity belonged to the first group of Gardner's Seven Intelligences and the other activity belonged to the second group. The choices were presented with large pictures and the name of the activity. When students clicked on the picture with the mouse, the computer said the name of the activity with a digitized voice and the picture of the activity was highlighted. Students chose by clicking the mouse on the picture of their preferred activity and then clicking on the next button to proceed to the next pair of choices. The students had to choose one of the activities before they could proceed. An activity from the first group of intelligences was paired with an activity from the second group of intelligences. The intrapersonal and interpersonal intelligences, however, were compared only with each other. This was done because these intelligences could be combined with any of the other activities. To consider them alone they had to be presented apart from the other intelligences. This computer-based test was used to increase independence, standardize the intervention and to administer the questions using sound, text and graphics simultaneously.

At the end of the test, students were presented with a summary of their preferences and a numerical score for each of the Seven Intelligences. The names Kibbles and Pantiggles were used to label the two groups. Twenty one choices were offered (there are no ties). The computer scored the assessment and assigned students to either group one or group two. By determining student activity preferences, differences in learning preference was indicated according to two broad categories based on Howard Gardner's theory of Seven Intelligences.

Comparisons

There were basically six comparisons of interest to this study. The total scores of achievement, retention and participation were compared between the hypermedia and word processing activities. This indicated the more effective computer use for each of these three factors of learning:
Achievement

Retention

Participation

The scores of the two learning preference groups were used to partition achievement, retention and participation. This indicated which type of computer use was more effective across varying styles of learning.

An independent statistical analysis was also made to determine whether more students showed improved scores after the hypermedia activity than the word processing activity. If it was assumed that contained within a group of students was a variety of learning style combinations, then an improved achievement score over a greater range of students would indicate that learning style needs were being better addressed.

In addition to these quantitative measures, observations were made by the teachers of the quality of interaction and participation of the students throughout the activities (Appendix C). They observed the demands on teaching and the potential for learning opportunities. Discussion was encouraged in relation to how the dominant learning modalities related to learning in the activity and how the components of this activity may or may not facilitate whole-mind learning.
Structure

All students had experience with cooperative learning and the groups were structured according to the Johnsons' five basic elements of cooperative learning. Training was provided before the beginning of each project to ensure that all class projects were being administered in the same way. Several visits were made to the classrooms during the activities to ensure that consistency was maintained over the course of the experiment. The students were assigned to groups of three, ensuring that at least one member of each group was proficient at designing HyperCard stacks and one was proficient at using a word processor. Some classes worked on word processing and some worked with HyperCard. The students were given the task of developing a body of information pertaining to a video presentation and discussion. Students had access to a library of graphics and sounds. All students participated according to cooperative learning structures. Each member of the group had a specific role to perform in accordance with the positive role interdependence described by the Johnsons (1984). One student's job was to control the mouse ("Mouser"). Another's job was to use the keyboard ("Keyboard Operator"). This promoted the use of text in the stacks. The third group member's job was to supervise and direct the construction of the project ("Pointer"). This included making sure all members were participating appropriately, using social skills and solving problems. The jobs were traded every ten minutes so that each group member had experience with each role. The group reached consensus with regard to the design and theme of the stack. Group processing occurred at the beginning (planning) and at the end (self assessment) of each session for five minutes. At the beginning, the groups determined the general structure of their project design, how they performed their roles and what skills (social and academic) were required. At the end of the session, each student had the opportunity to state what they felt went well and what could be improved in the next session. In each of the group processing sessions, the group completed a form (Appendix B). The first half of the form was completed before the activity. It requested the group name, the names of the members and three things that the group intended to accomplish. The second half of the form was completed at the end of the activity. At this time, the group members checked off the things that they said they would complete (if they were completed), listed three things that were successful during the activity and one thing that they would improve the next time. The total time for the activity was, therefore, forty minutes. Students interacted face to face to solve problems, practise social skills and plan their project. The final product was shared by all members and all rewards were group rewards. All students were individually accountable and responsible to the group. This was achieved through random individual
questioning from the teacher, group self checking, interviews and tests throughout the project.
Chapter Four

Results

To analyze the results of this study it must be realized that this experiment actually consists of two studies that are repeated with two separate topics and two series of tests. Students were presented with one topic and worked with the information in either a word processing or HyperCard environment. A pre-test, post-test and retention test were administered on the content of this topic. Then a second topic was presented. Students switched the medium they were using from word processing to HyperCard or from HyperCard to word processing. A pre-test, post-test and retention test on this second topic was then administered. The content of this second topic was thought to be significantly more difficult than the content of the first topic. A separate experiment, in effect, was performed for each topic. The results of these experiments can be separately analyzed and compared. The notation WP is used for word processing and HC is used for HyperCard. N is the number of subjects and SD refers to the standard deviation.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>pretest on topic 1</td>
<td>pretest on topic 1</td>
</tr>
<tr>
<td>Activity for one week using the Word Processor with Topic 1</td>
<td>Activity for one week using HyperCard with Topic 1</td>
</tr>
<tr>
<td>posttest on topic 1</td>
<td>posttest on topic 1</td>
</tr>
<tr>
<td>retention test on topic 1</td>
<td>retention test on topic 1</td>
</tr>
<tr>
<td>pretest on topic 2</td>
<td>pretest on topic 2</td>
</tr>
<tr>
<td>Activity for one week using HyperCard with Topic 2</td>
<td>Activity for one week using the Word Processor with Topic 2</td>
</tr>
<tr>
<td>posttest on topic 2</td>
<td>posttest on topic 2</td>
</tr>
<tr>
<td>retention test on topic 2</td>
<td>retention test on topic 2</td>
</tr>
</tbody>
</table>

Figure 4.1. Sequence of Events for Two Groups and Two Topics
Table 4.1. Word Processing Means and Standard Deviations for Topic 1

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Retention</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Mean</td>
<td>4.18</td>
<td>6.44</td>
<td>6.04</td>
<td>45.22</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.96</td>
<td>1.97</td>
<td>2.24</td>
<td>13.25</td>
</tr>
</tbody>
</table>

Table 4.2. HyperCard Means and Standard Deviations for Topic 1

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Retention</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Mean</td>
<td>4.19</td>
<td>6.08</td>
<td>6.56</td>
<td>54.17</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.72</td>
<td>2.84</td>
<td>2.47</td>
<td>8.50</td>
</tr>
</tbody>
</table>

Table 4.3. Word Processing Means and Standard Deviations for Topic 2

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Retention</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Mean</td>
<td>3.92</td>
<td>5.44</td>
<td>5.50</td>
<td>49.92</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.70</td>
<td>1.73</td>
<td>1.96</td>
<td>12.34</td>
</tr>
</tbody>
</table>

Table 4.4. HyperCard Means and Standard Deviations for Topic 2

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Retention</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Mean</td>
<td>4.26</td>
<td>5.07</td>
<td>5.41</td>
<td>56.56</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.29</td>
<td>1.59</td>
<td>1.56</td>
<td>8.16</td>
</tr>
</tbody>
</table>
Measures of Achievement and Retention

Table 4.5. Table Showing Both Treatments Yield Increase in Achievement Scores

<table>
<thead>
<tr>
<th>Topic</th>
<th>The Five Senses</th>
<th>Topic 2</th>
<th>The Sense of Sight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test</td>
<td>Post-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>WP</td>
<td>27</td>
<td>4.18</td>
<td>1.96</td>
</tr>
<tr>
<td>HC</td>
<td>36</td>
<td>4.19</td>
<td>1.72</td>
</tr>
</tbody>
</table>

Table 4.5 shows that both word processing and HyperCard activities produced an increase in test scores in the content area for both topics. A similar difference was found between pre-test and retention scores for all treatments in both topics. No significant difference between the post-test scores and the retention scores was found. A repeated measures analysis of variance was performed for each of the three comparisons for each treatment in each topic. A difference was held to be significant for p < 0.05.

Figure 4.2. Word Processing vs. HyperCard Test Scores for Topic 1

Table 4.6. Summary of ANOVA for Achievement for Topic 1

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>F-Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>0.14</td>
<td>1</td>
<td>0.012</td>
<td>0.91</td>
</tr>
<tr>
<td>Error</td>
<td>715.67</td>
<td>61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For topics one and two, repeated measures analyses of variance show that while both word processing and HyperCard activities yield improvement in achievement and retention over the pre-test scores, there is no significant difference between the level of improvement from using word processing versus that of using HyperCard.

**Measures of Participation**
Table 4.8. Summary of ANOVA for Participation for Topic 1

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>F-Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>1234.33</td>
<td>1</td>
<td>10.61</td>
<td>0.002</td>
</tr>
<tr>
<td>Error</td>
<td>7097.67</td>
<td>61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.9. Summary of ANOVA for Participation for Topic 2

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>F-Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>680.01</td>
<td>1</td>
<td>5.87</td>
<td>0.018</td>
</tr>
<tr>
<td>Error</td>
<td>7063.42</td>
<td>61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyses of variance for the effects on participation levels as observed by teachers for each of the two topics show a difference that is unlikely due to chance. In each case, the mean participation scores for HyperCard is higher.

**Measures of Learning Preferences**

The following is a table of correlations between all of the assessments of learning preferences. It includes the before and after measures of the computer-based test taken by the students, the teacher questionnaires and the same questionnaires completed by a teaching partner or a teaching assistant. The students' assessments provided an interval measure which was assumed to represent an underlying continuous measure. The teacher assessments and the alternate classroom personnel assessments were dichotomous. The staff members divided the students into two categories so students were assigned a one or a two, corresponding to their category. To compare dichotomous measures a Phi coefficient was used. To compare the interval measures (the before and after scores of the student self-assessments) the Pearson Product-Moment correlation coefficient was used. To compare dichotomous measures with interval measures the Point-Biserial correlation was used (McMillan and Schumacher, 1989).
Table 4.10. Correlations for Learning Preference Assessments

<table>
<thead>
<tr>
<th></th>
<th>(Computer-based)</th>
<th>(Computer-based)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student Assessment Before</td>
<td>Student Assessment After</td>
</tr>
<tr>
<td>Student Assessment After</td>
<td>0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
</tr>
<tr>
<td>Teacher Assessment After</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>Alternate Assessment After</td>
<td>0.16</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Notes:

- <sup>a</sup> The before and after measures of the computer-based student self assessments show a low correlation.
- <sup>b</sup> The correlation of all the teacher and alternate classroom personnel assessments with the computer-based student assessment are nearly zero.
- <sup>c</sup> The correlation of the before and after assessments made by the teachers is moderate (0.56).
- <sup>d</sup> The correlations between the assessments made by the alternate classroom personnel and those of the teachers ranges from low (0.33) to moderate (0.52).
- <sup>e</sup> The highest correlation (0.70) is between the before and after assessments made by the alternate classroom personnel.
Fourteen of the sixty three subjects (22.2%) showed unanimous agreement for all of the measures, both before and after. If the computer-based student self assessments are discarded because of low statistical reliability, thirty three of the sixty three subjects (52.4%) were assessed with unanimous agreement.

**Increased Number of Participants for HyperCard**

Since individuals could not always be identified reliably according to their preferred learning preference, the whole group was considered to see which medium showed more improvement for more students. An attempt was made to determine if the assumed heterogeneous styles were being accommodated more by one medium than the other in terms of participation scores. The achievement and retention measures could not be considered since the content of these measures changed when the topic changed. Only participation scores could be considered since the same criteria was used as measurement for both topics. Since the students switch mediums from one topic to the next, a count could be taken for the number of students who improved in participation for each medium being used. Nine students showed greater levels of participation for word processing activities as compared to thirty one students for HyperCard. Twenty three students showed the same level of participation for both activities.

<table>
<thead>
<tr>
<th></th>
<th>Word Processing</th>
<th>HyperCard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed Number of</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>Improved Scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Number of</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Improved Scores</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 40. DF = 1. Chi Square = 12.10. Critical Value for p < 0.05 = 3.84

Forty subjects showed improvement for one treatment or the other. If left to chance, half of these subjects (20) would be expected to improve for each treatment. The Chi Square value for goodness of fit is well above the critical value for p < 0.05 with one degree of freedom. This means the HyperCard treatment resulted in improved participation scores in significantly more students than did the word processing treatment.


Teacher Observations

Teachers were asked to answer three questions about their experience with the project (Appendix C):

1. All reported that the students were more involved, interested and cooperative during the HyperCard activities than during the word processing activities. This was in agreement with the measures of participation.

2. All teachers reported that there were greater demands on their teaching for the HyperCard activities. The students were less familiar with the HyperCard environment. The teachers needed to spend more time in teaching the various features of the program and in preparation.

3. All teachers predicted that over a long term, HyperCard would be the most effective teaching tool, resulting in higher learning gains for most of their students.

Other comments were made by individual teachers. They described the interactions during the activities, teaching demands and predictions of future learning outcomes during the activity. Comments are reported in tables 4.12 through 4.14.

Table 4.12. Teacher Comments Describing Interaction

<table>
<thead>
<tr>
<th>HyperCard</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>More interaction</td>
<td>More compliant</td>
</tr>
<tr>
<td>More discussion</td>
<td>Quiet</td>
</tr>
<tr>
<td>More involved because of the sound and so on</td>
<td>Just one person engaged</td>
</tr>
<tr>
<td>Talked more</td>
<td>More complaining</td>
</tr>
<tr>
<td>More focussed</td>
<td>More disagreements</td>
</tr>
<tr>
<td>More pointing and suggestions</td>
<td>Typist was focussed but the others were not</td>
</tr>
<tr>
<td>Positive toward others</td>
<td>always attending</td>
</tr>
<tr>
<td>during disagreements</td>
<td></td>
</tr>
</tbody>
</table>

45
### Table 4.13. Teacher Comments Describing Teaching Demands

<table>
<thead>
<tr>
<th>HyperCard</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lot more preparation</td>
<td>More independent</td>
</tr>
<tr>
<td>More features to teach</td>
<td>Very little interaction between teacher and students</td>
</tr>
<tr>
<td>Trying to accommodate more ideas</td>
<td></td>
</tr>
<tr>
<td>Students not familiar with HyperCard</td>
<td></td>
</tr>
<tr>
<td>With more training, students would be more independent</td>
<td></td>
</tr>
<tr>
<td>Requests for new cards, erasing, painting, moving through stack</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4.14. Teacher Comments Describing Future Learning Outcomes

<table>
<thead>
<tr>
<th>HyperCard</th>
<th>Word Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>The multi-sensory aspect of HyperCard will produce the greatest gains</td>
<td>Teachers did not provide any comments concerning future learning outcomes for word processing.</td>
</tr>
<tr>
<td>HyperCard will definitely show more gains</td>
<td></td>
</tr>
<tr>
<td>More open-ended, visual, auditory</td>
<td></td>
</tr>
<tr>
<td>More chance for creativity</td>
<td></td>
</tr>
<tr>
<td>HyperCard will produce the most gains in the long run</td>
<td></td>
</tr>
<tr>
<td>It demands manipulation of content rather than recall of content</td>
<td></td>
</tr>
</tbody>
</table>
Chapter Five
Discussion

The Achievement-Retention and Participation Contradiction

The results of analyzing the post-tests and retention tests for both topic one and two are in agreement. The analyses of variance show that no conclusions can be made from this experiment as to whether word processing or HyperCard activities result in greater achievement and retention in students. There is also no significant difference between any of the post-test and retention means. Measures of participation, on the other hand, indicate that students involved in the HyperCard activities exhibited more on-task behavior for both topics. This result is also supported by consensus in the teachers' comments at the end of the study. Teachers observed that students were more involved and on-task during the HyperCard activities. It seems contradictory that students spending more time on-task during an activity would not have this behavior reflected in improved achievement and retention scores. A possible explanation for this is revealed in the teachers' post-study observations. They unanimously agreed that more teaching was necessary for the HyperCard activities. As outlined in Table 3.1, HyperCard has more features, all of which interest primary students. It is also the newer of the two technologies and students are likely to have less experience in using it. The word processor is relatively easy for students to use effectively. Typing and using the cursor and delete keys is quickly mastered by students. It is more complicated, albeit more interesting, for students to create or manipulate graphical images, play with sounds, create buttons or fields and navigate through the cards of a stack. The intellectual demands are greater but more stimulating with HyperCard than with word processing. The fact that achievement and retention scores were relatively the same for word processing and HyperCard may mean that HyperCard use would actually yield an increase in these scores if more time were given for the activities. Students would then be able to learn more about the various features included in HyperCard and apply them in a content-related way. Indeed, all teachers predicted that HyperCard would be a more effective teaching tool over a prolonged period of time. However, it is a lesson for teachers that increased training is required before HyperCard can be expected to be an effective learning device.

Increased Participation for Cooperative Learning

As reported, HyperCard, in this study, encouraged more participation of students working in cooperative groups. This was supported by a consensus of the teachers reporting their
observations of the intragroup interactions. This result is significant to teachers wishing to use computers in cooperative learning groups.

Face to face interaction is one of the basic elements of Roger and David Johnson's (1984) cooperative learning model. Presumably, HyperCard can more effectively motivate students to interact. Interest level appears higher, probably due to the many facets of information transmission and the way it allows for open-ended interaction with the medium.

A goal of cooperative learning, in addition to academic outcomes, is increased social skill development. If students are participating more and therefore interacting more with each other, there is more opportunity to practice social skills. These skills, however, must be taught and will not develop on their own just because there is more opportunity to interact. Another of the Johnsons' basic elements is the teaching of social skills.

According to the cooperative learning theory and research described in the literature review, increased participation should, in the long term, yield higher academic gains. The Johnsons (1983) showed increased achievement for students of all ages, ability levels, in all subject areas and for all tasks. They list improvements in areas involving:

- concept attainment
- verbal problem solving
- categorization
- spatial problem solving
- retention and memory
- motor performance
- guessing-judging-predicting

Of note is how these skills overlap into several areas. They impact on all of Gardner's Seven Intelligences. A heterogeneous group composed of many styles can share a wide range of enhanced learning outcomes.

Slavin (1987) reported that cooperative learning had never reduced student achievement in comparison to traditional methods as long as the students are working toward some mutually valued goal and are dependent on the individual learning of all group members. Participation is an essential component to successful cooperative learning and this study
suggests that hypermedia is an appropriate tool to use to promote participation during computer related activities.

**The Failure of Learning Preferences Measures**

Two types of learners were defined by dichotomizing Howard Gardner's (1986) Intelligences into groups of learners who traditionally do well in school and those with dominant strengths in other areas. Essentially, two methods were used to assess these learning preferences. These methods consisted of a computer-based preference test for student self-assessment and a questionnaire in which teachers and alternate classroom workers divided the class into the same two groups based on their observations. Assessments were made before and after the study to check for statistical reliability.

The before and after student self-assessments showed a low correlation. Additionally, these measures had a low correlation with the teacher and alternate personnel assessments. These factors bring the veracity of these student self-assessments into question.

The before and after teacher assessments correlated moderately and the alternate personnel before and after assessments correlated reasonably well. The correlations between the teacher measures and the alternate personnel measures, however, were low to moderate. This challenges the accuracy of these measures as well. The assessment of thirty-three of the sixty-three subjects, or approximately half, showed complete agreement for both the before and after assessments and between teachers and their alternate classroom personnel.

One interpretation of this result is that there is a number of students whose styles are strong enough or discrete enough to be accurately indentified by the kind of approaches used in this experiment. The sports minded student or those who spend hours with books are common examples of students who are often typified. Further research may give a more accurate percentage of the students who are easily identified and perhaps give some indication of the value of this assessment considering all of the factors and interrelationships in a typical classroom. However, the results of the current experiment give a teacher only a fifty-fifty chance of identifying a student's dominant learning strengths based on the two broad categories of this study. It is expected that identifying students into one of the Seven Intelligences using the informal means typically available to teachers would be even less accurate.

Evidence to answer the fourth research question pertaining to the effect of learning styles on achievement and retention could not be answered. This failure of the learning preference measures to clearly identify students according to two categories precludes any definitive analysis of whether word processing or HyperCard activities better promote
learning for specific types of learners. It does, however, indicate that assessing students as to their dominant learning preferences, even in broad, dichotomous categories, is not a trivial matter. Teachers and other classroom workers, despite their training and professionalism and despite their professional requirement to administer educational programs according to individual needs, cannot assess students' optimal learning environment with complete confidence. The students' own assessments of their learning preferences is subject to change over a short period of time. This difficulty further accentuates the need for a learning environment that is conducive to all students. Completely individual programs can not be trusted to always address actual individual needs or styles based on informal assessments by professionals or reports from the students themselves. In fact, assuming that we always know how each individual student learns at every given moment is probably erroneous. Indeed, categorizing students in the past has led, usually unintentionally, to segregation or stigmatization. Gardner's (1986) research tells us that students learn with their whole minds. There may be dominant intelligences in some students at some times but it would appear that this is often a fluid attribute with dominant intelligences changing to suit the activity or the learning requirements. Similarly, students may show dominance in one or more areas but they still require their whole minds to completely integrate information with the learning process. It is better for a teacher to conceive of each student as belonging to an individual category of one and that this one member is an integral part of a larger whole group of students.

We as teachers may be tempted to try to find an easily applied test to indicate which prescribed methods and materials best suit an individual student's needs based on their type. This study would suggest that this solution is elusive. Time would be better spent getting to know each student and to apply a student-directed approach to teaching. In implementing a student-directed program, it is better to communicate than to categorize. This, of course, is much more time consuming, requiring more effort on the part of the teacher and student.

Learning preferences are not easily assessed but it is still a teacher's responsibility to provide student-centered programs. Therefore it is even more essential to find methods and tools that meet the learning needs of all students. In fact, if students could be easily classified, teachers still would not want to segregate students nor would they wish to stigmatize individuals by using tools that are for a singular purpose; for only certain kinds of learning. The Johnsons (1983) and others (Cosden and Lieber, 1986; Slavin, 1987) have shown that cooperative learning is a method that shows gains in all areas for all students. One can speculate that hypermedia may still be one of the tools to help all students. This is suggested by the results of the participation scores and teacher reports in
this experiment. Research to show similar gains in the academic areas for heterogeneous
groups is yet to be done.

It is assumed that many styles were used by the students during the activities even though
they could not be identified. Analysis of the data shows that students, on average,
participated more in the HyperCard activities. It was also shown that significantly more
students had improved participation scores for HyperCard. This suggests that the
improvement results from more students participating rather than a small group of students
improving their scores.

Recall that the students who used HyperCard for topic one, used word processing for topic
two and, likewise, those that used word processing for topic one used HyperCard for topic
two. The results of both topic one and topic two experiments are in agreement that the
HyperCard treatment produced higher participation scores. The cross-over of subjects
from one activity to the other supports the argument that the increased participation was a
result of the treatment rather than prior experience. If more students are participating for
HyperCard then this means that it is involving students with a greater range of learning
styles in the activity. This, again, would suggest that over a long term, this higher
participation for more students would result in increased achievement for more students
using HyperCard, regardless of their style of learning.

Summary of Findings

Listed below are the major conclusions of this study:

• No significant differences in achievement or retention were found between the
  word processing and hypermedia groups.

• The HyperCard groups participated more than the word processing groups as
  measured by teacher ratings during the activities and as reported in the post-study
  teacher comments.

• More time for the activities is needed to yield clearer results.

• The tools used to assess learning preferences were not statistically reliable.

• Learning preferences for some students are likely fluid and changing and therefore
difficult to assess.
• Increased participation scores for HyperCard are due to more students participating as opposed to the same participating students getting higher scores. This suggests that HyperCard involves more students regardless of learning preference.

Considering these conclusions, these hypotheses are suggested:

• Students use their whole minds in learning which requires an integration of dominant learning strengths. Categorizing students into groups based on discrete learning attributes has little meaning and could be harmful as a teaching practise.

• It is necessary to find tools that can address the needs of divergent learning styles simultaneously. Hypermedia may be such a tool but more research is required to support this conjecture.

• HyperCard has more features and is more complicated to use. Therefore more training is required to adequately use HyperCard than is required to adequately use word processing. Equivalent levels of training are required to yield clearer results.

Limitations of the Study

Some sources of possible error and problems with the experimental design were identified which led to difficulties in analyzing the results and raised questions as to the interpretation of the results.

Although all the classrooms involved in this study were extremely effective learning environments, there was a great range in teaching style, age of students, socio-economic status of the school community and skill and experience with both the cooperative learning approach and the use of computers. The subjects were indeed a heterogeneous population but each of the four schools were also unique in many ways. This allows for the possibility of a variety of random effects on the experimental measures.

As noted, the time allotment for activities was relatively short. This favors the activity that requires less experience and training (word processing). It also created an increased demand on the teaching load for the activity requiring more assistance (HyperCard). This, in turn, added the element of increased adult interaction as opposed to peer interaction. It may also have added a stress element for teachers which might have changed the way in which they related to the students.
There was some inconsistency between teachers assessing the learning preferences of their students. Teachers reported difficulty dichotomizing individuals with strengths in both groups. Additionally, it is not clear if teachers always perceived the qualities of each group in the same way. It may be that some perceived those students belonging to the traditional group as being studious or brainy and those in the second group as being underachievers or artsy. This is a somewhat distorted view of what Gardner (1986) intended with his Seven Intelligences. These inconsistencies may have led to difficulty in identifying learning preferences.

The teachers involved in the study made a commitment in terms of time, energy and training. Although every attempt was made to make both the word processing and HyperCard sessions equivalent, the learning of and use of HyperCard was more intensive for teachers. This is consistent with the findings of this study that students require more training for HyperCard. This may have produced an element of teacher bias toward the HyperCard treatment since more commitment was necessary to achieve competency in teaching the subject.

The experiment took place in late May and June. As teachers will report, this is likely the most distractible time of the year with thoughts of imminent summer holidays and a myriad of special events in the school. This distracts students from academic interests and fills up the teacher's timetable. This could have detracted from clearer results in terms of achievement and retention.

Suggestions for Further Research

This research suggests that HyperCard has a tendency to involve students more in educational activity than word processing. The experiment should be repeated with a much longer period of time than one week for each activity to ensure equivalent experience with each medium. As well, an extended training period in each medium prior to the experiment is also required to ensure equivalent expertise. This arrangement allows the subjects time for functional use of the media rather than sharing that time with training for the more feature-laden medium. It is suggested that this extended term of use of perhaps three of four months would yield significantly higher achievement and retention measures.

As a result of the inability of the measures taken to identify learning preferences, it was concluded that this type of assessment is not easily made because of the fluid nature of learning preferences and because of the inherent overlap of the intelligences that make up the whole mind. To categorize students on the basis of fragmenting their skills into
discrete classifications may do more harm than good by ignoring the importance of belonging to a whole group. It also detracts from the power of conceptualizing learning as a whole mind activity which integrates dominant strengths from the various intelligences. A future study would not attempt to identify types of students but would infer the ability of media to meet the needs of a wide variety of learning styles from statistical analysis of the whole group. If more students show improvement, one would conclude that a wider range of heterogeneous needs were being met.

A separate study pertains to the finding that approximately fifty percent of the teachers' informal assessment of students learning preferences agreed before and after the study and agreed with another professional's assessments. As speculated earlier, students who were identified unanimously may have been students whose styles were extreme enough to be more easily identified and would be consistently identified. A future experiment would verify whether or not this speculation is true or if these students are randomly selected. The percentage of students who could be reliably identified could be determined and perhaps other qualities of these identifiable students would be revealed. This would give information on which to base measures of style for this unique, easily classified sub-group of students. The next question would be whether it is a good idea to teach according to these students strong areas or if the areas of weakness need to be addressed. For example, should a visual learner be taught primarily using pictorial material or should this student be taught auditorily more often to compensate for this weakness?

One might reason that this line of experimentation contradicts the findings of this thesis which has stated that identifying students may lead to stigmatization. It is expected that some students may indeed be easily identified because of their extreme dominance in certain areas. However, it is the contention of this paper that the important aspect of this dominance is in how it can be integrated into a whole mind paradigm and how these students with individual strengths can be integrated into the whole group of students. Identification is not as important as integration into the whole. This still requires the use of holistic tools such as hypermedia and cooperative learning. In this way, the strengths of all students can be utilized with respect to all styles and with regard to all group members. This enables those students with extreme styles of learning to interact and to contribute outside of their dominant areas. This is good news for the often encountered child who is very gifted in one or more areas but does not have the skill to communicate that knowledge to others. This often results in frustration or misbehavior. Development of social skills and communicative behavior enable sharing of that knowledge, thereby giving it more meaning and giving the student more acceptance. Therefore, an experiment to determine if some students are easily identified may have some interest and may actually advance more
accurate measures for classifying some students, but it is more important to find ways to incorporate all students into an holistic approach to learning.

A valuable tool in this study was the observations made by teachers. An additional study would make extensive use of this tool. It would appear that the most productive use of hypermedia will be in a truly open-ended, student-directed way. An ethnographical study that relies on teacher observation, student reports and analysis of a product could yield valuable information as to the effective use of this increasingly prevalent classroom instrument.

The issue of effectiveness of communication was raised several times in this thesis but not directly dealt with in the experiment. Future study in this area would compare the effectiveness of communicating information, compiled in either word processing documents or in HyperCard stacks, to other students. Again, the multi-sensory aspects of hypermedia will be of interest in both the creation of information and in the reception of information.

Since it appears that participation is increased in cooperative groups using HyperCard, more detailed information related to group interaction must be obtained. The development of social and collaborative skills is a central element of cooperative learning. The ways HyperCard can be used to develop collaborative skills must be studied. For instance, how does the object-oriented nature of HyperCard programming facilitate collaboration? Can students develop parts of a stack independently and merge these parts in a jig-saw type approach? Which specific collaborative skills are most important? Which elements of HyperCard foster collaboration? If participation is increased for HyperCard activities, it is expected that more positive learning attitudes will be developed and that there will be increased tolerance for other students with a variety of differences. These differences include not only learning styles but also differences in ethnic background, gender, ability, handicaps, etc.

Some of the questions to be explored were outlined in chapter two of this thesis under the heading Research Directions. This experiment has added some focus to these issues. They include:

- How much learner control is optimal when using hypermedia? Does the cooperative learning environment tolerate less structure allowing for more learner directedness? The participation data from this experiment suggest that less effort must be made by the teacher to ensure students remain on-task.
• Does the cooperative learning structure allow for high and low ability students to both gain academically, to tolerate differences in style and to enjoy the learning activity? Again, the analysis of data from this experiment suggests that more students participate but not whether academic advances can be expected.

• Does hypermedia allow for a group of students of heterogeneous learning preferences to learn simultaneously in cooperative groups? This research showed that randomly assigned students in cooperative groups learned from both word processing and HyperCard but could not determine which medium was most effective. Identification of learning preferences was a difficult and perhaps dangerous thing to do. Future research should infer gains for learning preference differences through statistical measures applied to the whole group.

• Can electronically networking computers be used to link cooperative group members across distances? It will be interesting to see if participation is dependent on the physical proximity of students.

Literacy

The importance of this research to education is in its relevance to improving communication and in learning how to communicate. The interpersonal dynamics of cooperative groups and the use of classroom technology has been discussed. The topic is linked to one of the main reasons that education exists - literacy.

The basic definition for literacy is the ability to read and write (Grolier's Academic Encyclopedia, 1991, p. 386). However, there are many definitions to suit the time or current needs of a society. In the past this has ranged from the ability to read or write one's name to the concept of functional literacy, which are the skills needed to perform everyday reading, writing, and arithmetic tasks.

Literacy first appeared around 3100 BC, when the Sumerians used a system of symbols to represent speech to address a developing commercial structure. Various cultures over the years developed cumbersome systems to represent speech sounds. Reading and writing became a tool to record doctrines, myths and genealogies. It was primarily a mnemonic device which did not need comprehension or critical skills. In early Greek society, most people learned what was written down by hearing it read aloud. Plato was among the first who believed that by carefully scrutinizing prose, people could evaluate the world and themselves. In medieval Europe, literacy was preserved by the Roman Catholic church but
was kept from common people. Most of the literature was not original and preserved in Latin. Not until the renaissance with the establishment of universities and the invention of the printing press did literature enter the public realm. It remained in the domain of the elite until the industrialization of the nineteenth century. In the twentieth century, governments and international agencies began to combat illiteracy. As of 1979, two thirds of the world were thought to be literate and at least one half were functionally literate.

The history of the development of literacy reveals several trends. It has developed from a system to represent speech to one that presents and encourages the development of ideas. Its accessibility has grown from an elite few to all but about 1.5 percent of the North American population. Its method of recording has changed from stones to paper to electronic media. Literacy has had many manifestations, many uses and an increasing impact on society.

Technology is changing the way we think about literacy. Multimedia is becoming more accessible, easier to produce and less expensive. Some current writers embrace this trend as an unprecedented opportunity for learning and communicating (Thornburg, 1989). Others lament the apparent devaluation of the printed word and equate this to the demise of literacy (Levy, 1990). Much of the latter's concern is based on the present use (or misuse) of commercial television with its blatant appeal to the senses but disregard for depth of thought. ...multimedia will one day be utilized in many instances where previously, logical communication sufficed quite nicely - except for the fact that one had to be literate to participate (Levy, 1990, p. 70). Granted, the average television sit-com may be designed with the lowest common denominator and widest viewing audience in mind. Interactivity may be mostly confined to the Nintendo machine. This study's strongest result is an indication that more people are motivated to participate in multimedia than with a text-based medium. Further, it is suggested that this participation is not confined only to those skilled in logical communication, verbal techniques or the use of printed material. Rather, those skilled in other areas are able to participate within their areas of dominance. But Levy's point is not lost. Indeed there is a danger of losing the richness and depth of text-based literacy to a superficial, even mindless television-style media.

Both Thornburg (1989) and Levy (1990) agree that multimedia is here to stay. It is the responsibility of educators, not to avoid this new technology, but to master it with our students. It must be regarded as an avenue toward literacy. It is an avenue that can be explored by all students. Students with verbal skills can still be involved but so can the artistic, the musical and even the athletic. If these students are involved together, then each of their skills can be used to integrate with the skills of the others. Research shows that
cooperative learning is a likely strategy for integrating the strengths of heterogeneous groups and this experiment suggests that hypermedia increases the levels of participation for many students.

There are many cases of superficial literature and there are many cases of good educational television. Television at its best is very good indeed, providing an aspect to information transmission unavailable to written media. There are certainly cases of sound educational hypermedia. The Whales stack (Allen, 1988) is one such example as is the Ninja Turtles activity described at the beginning of this thesis. Hypermedia can add new dimensions to literacy but it can also be abused if used to produce passive, superficial or inaccurate products. In the past teachers strived for student competence in printed material. Now teachers must strive for excellence in interactive, multi-sensory technology. Table 3.1 lists the features of text intensive word processing and those of the multi-facetted HyperCard. HyperCard includes all the features of word processing and adds to them. Clearly, a text based approach is just as feasible in hypermedia as it is in word processing. As noted, however, with the increased number of channels available for manipulation of information, comes an increased burden of teaching and learning.

Cooperative learning offers a route to integration of many senses, styles and ideas. Hypermedia offers an affordable, easy to use, multi-user tool. These two strategies provide an appropriate vehicle to mastery of the new concept of literacy. Without mastery of the written word, students still cannot be regarded as literate, but neither can they now be regarded as literate if that is the full extent of their abilities to communicate. Literacy need not die. With the aid of skilled teachers and students, literacy will merge with multimedia and evolve into a new and powerful instrument of communication and learning.
Bibliography

Allen, D. (1988). The Whale Stack [computer program]. Victoria, British Columbia: Marigold Elementary School, Grade 3&4. (HyperCard stack produced by students under the direction of teacher Barbara Kemp; Designed by principal David Allen; Technical assistance from Doug Wilson; Grant received from Apple Canada Education Foundation)


Provincial Education Media Resources, Ministry of Education, Province of British Columbia (1989). *This is You Series [Video Tapes]*. Richmond, British
Columbia. (A video tape series of cartoons hosted by Jiminy Cricket for primary grades which examines the role and function of the five senses.)


Appendix A.

Teachers' Assessment of Differences in Learning Preferences

Please divide your students into the following two categories according to activity preferences that best describe them. A perfect match is not required. Just choose the most likely category.

<table>
<thead>
<tr>
<th>Word activities, talking, listening, puzzles, thinking activities, problem solving, number activities, individual activities.</th>
<th>Athletics, physical activities, musical activities, artistic or spatial activities, interpersonal activities.</th>
</tr>
</thead>
</table>

Teacher's Name: ___________________________  Date: _______________
## Appendix B
### Project Planning and Evaluation Form

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Group Members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Today's Date: ____________________

### Today we will do these three things:

1. 
2. 
3. 

### The three best things we did today were:

1. 
2. 
3. 

### Next time we will do this better:


### We, the undersigned, agree that all this information is true and that we have done our job for today.

_________________  ___________________  ___________________
Appendix C

Teacher Questionnaire

1. Did you notice any difference in the way students interacted during the two activities? Please Explain.

2. Did you notice any differences in the teaching demands during each of the two activities? Please describe.

3. Which activity will produce the greatest gain for most students in the long term?

Teacher's Name: _____________________________ Date: ___________
Appendix D

Videos

Two videos were used to present information to students at the beginning of each of two activity sessions. The topic of each video was the content for which students were responsible for learning. A description of each follows:

Video for Topic 1:
This is You Series: You and Your Five Senses

Jiminy Cricket hosts this instructional series. The video uses music, animation and humor to illustrate how people and animals use their five senses.

Video for Topic 2:
This is You Series: You and Your Eyes

Jiminy Cricket again makes use of cartoon characters dancing and singing to explain how the eye works and to present its various parts. The importance of adequate care and attention is emphasized. This video is more specific and more technical.

Both videos were acquired from the British Columbia Provincial Educational Media Centre (PEMC) in Richmond, British Columbia. PEMC is part of the B.C. Learning Resources Branch of the Ministry of Education.
Appendix E

Computer-Based, Student Self-Assessments of Learning Preferences

The following is a printout of the computer screens used by students to assess their preferred learning preferences. The screens presented here are reduced to thirty five percent of their original size. The text displayed is accompanied by a digitized voice that speaks the words when the student points to them with the mouse. The students make their choices by clicking on the corresponding picture. This encloses the picture in a box and highlights the words as illustrated in screen one. An arrow appears with the words Next Question displayed on it. When the students are ready, they click on this arrow to advance to the next screen with the next pair of choices. The final screen displays the results of the test. It gives a score for each of the Seven Intelligences and assigns the student to one of two categories named Kibbles or Pantiggles. A printout of this page is available by clicking on the printout button. The computer keeps a record of all the students' scores.
Which would you rather do?
Answer Riddles
or
Run Fast
9

Which would you rather do?
Play in the Gym
or
Play Word Games
10

Which would you rather do?
Solve a Maze
or
Color a Picture
11

Which would you rather do?
Take Pictures
or
Learn New Words
12

Which would you rather do?
Play Card Games
or
Play the Drum
13

Which would you rather do?
Teach Other People
or
Learn by Yourself
14

Which would you rather do?
Go to the Library
or
Go for a Walk
15

Which would you rather do?
Watch Animals
or
Count Birds
16

Which would you rather do?
Learn to Use a Machine
or
Listen to a Poem
17

Which would you rather do?
Read Animal Books
or
Sing Animal Songs
18

Which would you rather do?
Listen to the Radio
or
Exercize
19

Which would you rather do?
Be Alone
or
Join a Group
20

This is the profile of Steve's preferences:

<table>
<thead>
<tr>
<th>Domain</th>
<th>Level</th>
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</thead>
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<tr>
<td>Musical</td>
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<tr>
<td>Logical/Mathematical</td>
<td>6</td>
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<tr>
<td>Spatial</td>
<td>6</td>
</tr>
<tr>
<td>Bodily/Kinesthetic</td>
<td>3</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>9</td>
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</tbody>
</table>

Steve/Estimated 9

This person is mostly a Panaggregate.
Appendix F

Computer Assessment Screen Printouts

The following are screen printouts of the tests used to assess students knowledge of Topic 1 (The Five Senses) and Topic 2 (The Sense of Sight). Twelve screens in each assessment display ten questions visually and verbally. When the student points the mouse at the text on the screen, a digitized voice speaks that text. The student selects their choice of answer by clicking on the corresponding picture. This advances the presentation to the next screen. The computer maintains a record of the scores of all students. The screens are reduced here to one quarter of their original size.
The Five Senses

Which one is not one of the five senses?

Which animal hears best?

Which animal has the best sense of smell?

Which is used for the sense of hearing?

Which is the most important sense for most people?
Which sense tells temperature?

Which animal cares most about taste?

Which sense is used by a cat's whiskers?

Which is an animal?

Which one is not one of the five senses?

Thank You
Topic 2  The Sense of Sight

The Sense of Sight

What part of the eye turns things upside down?

- Retina
- Lens

Which animal has both rods and cones?

- Bat
- Human

Which animal sees the farthest?

- Bat
- Eagle

What part controls brightness?

- Eyebrow
- Iris

What part lets us see colors?

- Eyelid
- Cones
- Rods

Human

Chicken

Which animal has both rods and cones?

- Bat
- Eagle
Which animal has 12,000 eyes?

Enough Sleep

Which is not a way to protect your eyes?

No Sharp Objects

What protects your eyes from dust?

Eye lid

Which animal only sees things that move?

Eye brow

Thank You