THE THREE C'S:
CONSTRUCTIVISM, COOPERATIVE LEARNING, AND COMPUTERS

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Abstract

This study examines cooperative learning in a technology-rich educational environment. It was hypothesized that students who had more experience working collaboratively would be more favorable to the activities in the study than their counterparts, and would demonstrate greater use of higher-level thinking skills than the others. Other issues were researched as well, including how subjects interacted with each other and the facilitator, whether subjects internalized the skills, and how much students felt ownership over their learning.

Eight students from two fifth-grade classrooms at a suburban elementary school participated in this project. The sample selected was representative of their classroom populations with regard to gender, ethnicity, and academic ability. Qualitative results were acquired through interviews with each subject before and after the activities.

Results indicated that past experience with cooperative learning did not predict subjects' favorability. Individual learning style and group cohesiveness, however, were stronger indicators of how much the subjects enjoyed the activities. The role of technology was not a significant influential factor, although subjects were clearly excited about using it in an academic environment. Future research could examine how groups function as a result of its members' personalities and learning styles, and how technology is used with those variable characteristics.
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Introduction

General Statement of the Problem

The 1990's are an exciting and complex time in educational reform. Due to increasing multicultural awareness in society, educators are implementing classroom learning strategies that offer students more explorative and team-based learning than in the past. Also, with technological advancements becoming available in schools, teachers are finding ways to supplement their curriculum with computers. Our children's future success in our global community is a function of their ability to use these skills. Therefore, it is crucial that educators implement curricula that empower students to develop the ability to work with others, and to apply the critical thinking skills they build in the classroom to the "real world." The purpose of this thesis was to examine some of the psychological and educational interactions that occur when interactive computer technologies are combined with cooperative learning, by identifying major concepts and issues as reported by students who are learning interactively with both peers and computers.

Background of the Problem

Just as Vygotsky (1978) has emphasized the importance of education through interaction, Adams and Hamm (1990) suggest that strategies such as role playing help students understand different viewpoints. Consequently, students learn skills in
clarifying information, organizing material, and focusing the scope of analyzing a problem. This constructivist application to education is apparent in both cooperative learning strategies and interactive educational technology applications.

As Slavin (1991) explains, cooperative learning creates a team atmosphere, where a student’s peers are dependent upon and supportive of him/her. Evans (1994) describes cooperative learning helping develop a bond among students, creating increased opportunities for student participation, and allowing students to make their own rules and decisions. He states that this “autonomy and sense of ownership can be a strong positive force in motivating students to learn” (p. 36).

The social skills once only thought to be enhanced in a setting such as a student’s classroom, can now also be developed through technological advancements. Since, in the real world, cultural barriers are deteriorating quickly through the influence of interactive computer programming, these new technologies need to be available for our children in the classroom as well (Laszlo & Castro, 1995). In addition, the primary role of technology is to be an “invisible” part of the curriculum, offering increased flexibility to learning (Paul, 1994; Laszlo & Castro, 1995).

As educators begin implementing modern learning methods such as these, it is hoped that their students will be able to benefit from these improvements. In order to accomplish
great things, though, we need to understand how best to apply these developments to educational situations.

Just as new advancements can improve old situations, these advancements also bring new challenges. Often, we are forced to group children at a single computer terminal due to lack of resources. This is not the problem. The problem is that the software being used, which is generally designed for one child, can be incorporated into more group-based activities, but is not. In order to create more cooperative computer lessons, though, we need to learn more about the higher order cognitive skills that are needed to function in this modern learning strategy.

Significance of the Problem

"Information Superhighway" is a term that was coined by Vice President Al Gore, about 20 years ago (Speech by President Clinton at "Net Day '96," Ygnacio Valley High School, Concord, CA, March 9, 1996), to describe the continuously growing opportunity for communicating in the world. After reviewing the literature, it is clear that students' access to the Information Superhighway, when combined with a constructivist pedagogy like cooperative learning, has "the possibility of attaining simultaneous goals within the cognitive and psycho-social domains" (Mevarech & Light, 1992, p. 279).

The adaptability of technology across the curriculum, also provides teachers with additional quality
time to assist students individually (Laszlo & Castro, 1995). Teachers are unable to meet all the needs of all the students in today's large classrooms. However, in a computer learning environment, students can be actively engaged in learning, and the teacher can organize clerical work and lesson plans more effectively. Just as a bee collects pollen from flower to flower, the teacher is now free to travel around the room interacting with students (Mandinach & Cline, 1994). Teachers can also have more interaction with other teachers, inside or outside of school, through video-conferencing or electronic-mail.

This quickly growing field is in demand for answers to questions about complex psychological interactions. It seems that the best way to discover what participants in this type of instructional design experience, feel, and perceive, is to evaluate their personal responses to the intervention. Also, since this is a new area of educational research, there has not been extensive study done thus far on the topic. Thus, this thesis hopes to provide some insights into the application of modern educational methods.

Definition of Terms

**Constructivism** - In this study, the aspect of constructivist theory that will be explored is a student's learning by actively participating in higher-level cognitive thinking strategies such as simulated realistic decision-making, and using more than one cognitive skill to find
solutions to open-ended problems.

**Cooperative learning**- In this study, cooperative learning will be defined as organizing students into small groups, including different genders, ethnicity, and ability levels, helping each other learn (Slavin, 1991).

**Interactive educational technology**- In this study, interactive educational technology will refer to the educational multimedia software program, "The Great Ocean Rescue," by Tom Snyder Productions, Inc., as well as the activities that are included with the teacher's guide.

The following variables will also be examined, as the characteristics which cooperative learning and educational technology have in common, according to the literature reviewed. Each is the basis of at least one interview question (see Appendix A).

1. **Resourcing:** Where the students went to look for information.

2. **Ownership:** To what extent did the student feel that s/he was actively involved in the decision-making process, and in using learning strategies that helped her/him understand the
material.

3. **Communication:** The type of interactions that students experienced in the groups (i.e. how they "got along").

4. **Flexibility:** How adaptable the students felt that their peers and/or the computer were in helping them learn.

5. **Feedback:** To whom/what did the students go to for guidance and what served best as a monitor to help them understand the material?

6. **Multicultural:** Students' feelings and input about working with peers who have different cultural backgrounds, academic abilities, or are of another gender.
A Review of Related Literature

This review will take an in-depth look at the potential application of psychological constructivist theory. First, the classroom roles of both cooperative learning strategies and computer learning environments will be examined separately. Then, the two instructional methods will be discussed as they fit together in designing innovative curriculum. Finally, we will look at current developments in the field of Educational Technology, and how to use them as a foundation for developing computer curriculum for cooperative learning groups.

Constructivism: A Theoretical Background

Both Piaget and Vygotsky claim that a child learns by interacting with the physical environment; consequently, s/he is an active participant in learning new concepts by forming meaningful connections (Strommen & Lincoln, 1992). According to Piaget, learning depends on the child's present maturational stage of development, but is also highly influenced by the amount and type of interactive learning that is experienced (Bybee & Sund, 1982). The child has a natural need to assimilate (organize) and accommodate (adapt) new information into existing psychological structures, in order to reach cognitive equilibrium. This is done within every structure, eventually leading to understandings of
abstract ideas.

Similar to Piaget's theory, Vygotsky (1978) claims that in order to reach a higher cognitive level, meaningful learning must occur. In addition though, a child also needs to be guided by a facilitating adult or an "expert" peer, to reach his/her potential. This process, called scaffolding, encourages independent thinking by using open-ended, leading questions that challenge the child to grasp ideas beyond his/her maturational stage. Thus, a guiding, facilitating adult helps to create a "Zone of Proximal Development" (ZPD), or the distance between what the child can do alone, and what is possible with guidance.

Both Piaget's and Vygotsky's models are used today for educational techniques that help children achieve increased cognitive complexity and heightened insight while learning (Strommen & Lincoln, 1992). However, Vygotsky's concepts of ZPD and scaffolding have been the focus of much of the recent research (Atkins, 1993; Barbieri & Light, 1992; Mandl & Renkl, 1992; Mercer & Fisher, 1992; Mevarech & Kramarski, 1992; Mevarech & Light, 1992), which is due to their ability to explain complex interactions between students, teachers, and educational technology. For example, some concerns focus on changing our traditional educational standards of producing "knowers" (students who simply passively receive a "conceptual toolkit" of information), to developing more holistic, active learners, who strive for personal
development (Laszlo & Castro, 1995). Others emphasize the "Vygotskian" structure of learning as directed by an expert practitioner (Atkins, 1994). In either case, and in accordance with current movements in education, the most necessary and influential factor in learning is the interaction between the child and the environment.

Another advantage of Vygotsky's constructivism is that a child becomes aware of the metacognitive learning strategies that work best for him/her, which instills high levels of abstract thought (Laszlo and Castro, 1995). It is through practicing this type of critical thinking, and its application to real world issues, that students consciously become aware of how to continue making connections in other areas of their school and home lives.

**Cooperative Learning**

Constructivism is manifested in cooperative learning. There is a common emphasis on critical thinking and creative problem-solving, that has the potential to be applied across the curriculum. For example, Adams and Hamm (1990) describe programs in language arts, science, and mathematics, that encourage students to use each other as planning strategists in order to solve a common problem. Teachers must facilitate an environment in which children are taken seriously (Patrick, 1994). Students must be given the choice to actively suggest thematic activities (Crawford, 1993).
Consequently, students will know that their ideas are important, and will feel comfortable taking risks and sharing their thoughts with others in the classroom community (Patrick, 1994). By interacting with others, each child gains more insight, communication skills, social skills, and strategies for understanding material, than if s/he were to have worked individually in a direct-instruction method.

Today's classrooms are composed of children from different multicultural backgrounds, with a wide range of abilities, interests, and ideas (Crawford, 1993). Through cooperative learning groups, students learn to relate to peers who differ from them in these ways, while also building a sense of group cohesiveness (Adams & Hamm, 1990). The philosophy behind cooperative learning is to create a positive, productive, and respectful classroom community, that reflects the way society functions (Adams & Hamm, 1990). To do this, educators need to foster an environment in which children are empowered to make meaningful and personal associations between academic material and social skills (Manning & Lucking, 1991).

There are several forms of cooperative learning. All involve organizing students in small groups, in which they help each other learn academic material (Slavin, 1991). Other common aspects include heterogeneous group composition, group accountability for completing projects, building individual social skills, teacher guidance, and dynamic,
student-generated topic discussions, presentations, or competitions (Manning & Lucking, 1991). The PACT Project at The University of California, Irvine (1988), summarizes the main facets of cooperative learning as: team building, interdependence, individual accountability, and debriefing.

Clearly, cooperative arrangements are advantageous for teachers. Cooperative learning can divide overcrowded classrooms for more effective instruction (Evans, 1994). In addition, the teacher's role changes from conducting direct, one-way instruction, to becoming a facilitative resource person. This allows the teacher to "float" around the classroom, enabling him/her to interact with more students and have more freedom than in traditional, direct instruction strategies. (Manning & Lucking, 1991).

Students also benefit from cooperative experiences. As they learn, they can validate their own ideas, answer each other's questions, actively use problem-solving skills, and have more personal interaction with a more mobile teacher (Adams & Hamm, 1990).

Implementation Designs

Slavin (1988, 1991) has developed numerous practical cooperative learning designs using the above characteristics. The basic formats are: Student Teams-Achievement Division (STAD), Teams-Games-Tournament (TGT), and Jigsaw. Other designs are used in specific academic areas. Team Accelerated Instruction (TAI) diagnoses students'
mathematical levels, organizing them into mixed groupings and pairs. For the language arts, Cooperative Integrated Reading and Composition groupings (CIRC) help to integrate relevant activities into basal reading curriculum requirements, while also structuring interaction between students. UC Irvine's PACT Project (1988) reviews additional methods for incorporating cooperative learning into the classroom, such as Think/Pair/Share, and The Round Table. Through these techniques, the classroom becomes a forum for interactive student-centered learning. Students construct meaning and connect academic content with critical thinking skills that are transferable to situations encountered outside of school.

Teacher's Roles

Untrained teachers may be eager to adopt cooperative learning techniques, however, they will most likely use ineffective forms of the approach (Slavin, 1991). Educators need to be informed of the reasons for implementing heterogeneous groupings in their classrooms, and how to facilitate them correctly, to have the most positive effects. Battistich, Solomon, and Delucchi (1993) examined the quality and frequency of group interactions in 18 fourth and sixth grade classrooms in the San Francisco Bay Area. The classrooms were from two districts. District 1 children were from a predominantly white, middle-class, suburban community. District 2 children were from an ethnically and socioeconomically diverse urban community in which one-fourth
to one-third were Limited English-Proficient (LED) or non-English speaking. Results showed that both districts worked in groups at least occasionally. The quality of the group interaction effected outcomes, and was positively associated with achievement. Frequency and quality significantly influenced student perceptions of a positive classroom environment, and their intrinsic prosocial motivation. This indicates the importance of training teachers to use cooperative learning appropriately.

As discussed above, the teacher's role changes drastically in a cooperative learning classroom. This transformation, from serving as a traditional, one-way "giver" of information, to a monitoring, accessible, resource person, is crucial in developing a constructivist classroom. Teachers can accomplish this modification by focusing on interacting with students, rather than on intervening (PACT Project, 1988). With this in mind, teachers can use other management skills to guide students. For example, groupings should include a variety of students with different cultural backgrounds, social skills, ability levels, gender, and interests (PACT Project, 1988). Another strategy is modeling and teaching collaborative skills directly to students, as a teacher would for any other subject matter (Patrick, 1994). Once they are trained to listen and respond to others, how to praise peers on accomplishments, feel comfortable asking for help, and to be able to comprehend and paraphrase what others
have said, students will benefit greatly from cooperative learning. Children who learn to trust their ideas, use others as resources for information, and make independent decisions about what they have learned, will be better prepared to use those skills in the real world (Adams & Hamm, 1990).

**Research Findings**

Research on the use of cooperative learning has shown positive effects in children's academic achievement, social integration and friendship, mainstreaming and peer acceptance, and self-esteem (Slavin, 1991). Patrick (1994) found that her fifth graders' work habits improved after conducting a pilot study in her own classroom. She reported higher quality in children's journal writing, and greater internalization of metacognitive strategies. In addition, her students became more comfortable in their groups, showing a change in collaborative skills and interaction behaviors. She explains, "they sat very close with their heads together ... and their voices were quiet and calm because if they were taking turns and listening to one at a time retell or give another explanation, there would be only one child talking and the rest would be listening" (p. 177). They also showed an increased level of self-esteem, an ability to stay on-task longer than before the intervention, and seemed to transfer certain active listening skills to other situations because there became fewer personal conflicts to resolve.
Johnson, D., Johnson, R., and Taylor (1993) examined the effects of cooperative learning on the achievement, self-esteem, and social acceptance of high-ability students. Subjects were 34 middle-class, high-ability fourth grade students from a Midwestern suburban elementary school. The subjects participated in six instructional sessions in either cooperative or individual instruction conditions. Results showed that the students in the cooperative learning condition performed better than their peers in the individual instruction setting on recall, higher level questions, total test score, academic self-esteem, group cohesion, and feelings about cooperative learning. These findings indicate that working in cooperative groups promotes the use of higher level reasoning, and is beneficial for the academic self-esteem of high-level students.

Computer Learning Environments: Educational Technology

Just as educational and psychological constructivist theories help to structure interactions between students and teachers in the cooperative learning classroom, cognitive and psycho-social development are currently being researched in conjunction with computer environments. Related issues will be explained as they apply to constructivism, and as they contribute to recent research and programs.

Constructivism and Educational Technology

There is an abundance of literature regarding Computer
Assisted Learning (CAL) in schools, and using Instructional Technology (I.T.) in the classroom (Light & Mevarech, 1992). There are some reasons for this phenomenon. First, is the issue of the globalization of communication. Outside school walls, children are surrounded by a world of instant access to knowledge. This societal development calls for drastic educational reform (Strommen & Lincoln, 1992). We need to create learning environments that are beneficial to both students and society.

Second, educational technology can also facilitate constructivist type learning. For example, I.T. can provide feedback at the learner's own pace (Laszlo & Castro, 1995) just as Vygotsky's ZPD and scaffolding techniques do (Vygotsky, 1978). Similarly, programs can be altered to match an individual student's ability level, as each child has different motivational needs (Mevarech & Light, 1992) and varying experiences to contribute to school (Strommen & Lincoln, 1992). It is also possible to correspond with people inside and outside of the classroom through videodiscs, video-conferencing, and electronic-mail; consequently, curricula can be made flexible and portable (Bell & Elmquist, 1992). Finally, technology also facilitates active experimentation, which is critical for creating personal meaning (Strommen & Lincoln, 1992). I.T.'s power for initiating creativity actively involves the student in learning, inducing a relationship "centered on responding
to, empowering, and enlivening the learner" (Laszlo & Castro, 1995, p. 10).

Biddlecomb (1994) sites Toys, a mathematics computer curriculum, as an example of constructivism enhancing personal meaning. This program was designed to build critical thinking skills in the realm of learning rational number operations. Unlike traditional fragmented classroom presentations of math concepts, this program's instructional design builds on a child's current math knowledge. More advanced math understandings then arise naturally, as students interact with their personalized computer environment. Biddlecomb (1994) relates this aspect of the program to Vygotsky's theory, noting "tasks involving composite units form a scaffold ..." (p. 95). Toys is an example, then, of how the above mentioned characteristics can integrate I.T. into our changing educational curriculum.

Similar to cooperative learning, computer applications require the teacher to be a facilitator. Although the computer is flexible in presenting individual opportunities for learning, the teacher needs to make those opportunities meaningful and educational. In other words, the technology holds all the tools, but those tools need to be accessed to form, in this case, mathematical problems to solve. However, as Bell and Elmquist (1992) stress, the role of I.T. is not to replace interpersonal contact with teachers and peers, but is to fit in with the classroom environment in order to
promote motivation and self-esteem.

Benefits to Students and Teachers

In 1993, Bell Atlantic wanted to test the outcome of implementing technology into an impoverished school district. The company installed computers in all the homes, classrooms, and resource rooms of all seventh graders attending Christopher Columbus Junior High School in the Union City school district in New Jersey (NIIAC, Kickstart Initiative, 1993). The result of implementing technology at Christopher Columbus was that reading, writing, and math scores of the students improved from below average to 10 points above the statewide average. In 1995, the students continued to outperform students from other schools. Parents became more involved in their children's education, and students showed significant excitement, motivation, and interest in learning.

The critical factor in the success of this program was the supportive attitudes of the teachers, probably due to the training session conducted by Bell Atlantic (NIIAC, Kickstart Initiative, 1993). Also, the administration provided teachers with opportunities to be active decision-makers and coordinators in the process of developing the program. Consequently, teachers were very enthusiastic about integrating these ideas into their own classrooms. Parents were encouraged to become involved as well, and could easily access the school via computer, strengthening communication between home and school, even among non-English speaking
parents. Thus, with the common goal of improving their children’s education and future success, parents, teachers, and administrators implemented Bell Atlantic’s technological vision successfully.

Combining The Three C's

In combining the theory of constructivism, the classroom strategy of cooperational learning, and the application of computers to the curriculum, we can develop an exciting classroom framework for extremely positive learning experiences. In this section, recent research, current developments, and cutting-edge issues will be presented to establish the need to look ahead—past what has been proven successful already—into new realms of educational reform.

Making a “Match”

Constructivism, as an educational model, is reflected in both cooperative learning and educational technology, which have many characteristics in common. Following, is a description of six of the factors that they share, as described by Means (1994) and The President's Advisory Council on the National Information Infrastructure (NIIAC, Kickstart Initiative, 1993).

1. Resource Skills: When students use peers and computers as resources in the classroom, they are preparing for success in the same way that society does. Children who learn with
peers and computers will understand how to function in the real world. Students will be proficient researchers, will be more marketable for employment, and will be proficient in analyzing complex information.

2. Ownership: By restructuring the classroom to be student-centered, teachers become facilitators, allowing children to actively participate and create personal meanings for information.

3. Communication: Both cooperative learning and technology "bring the world to the classroom" (NIIAC, Kickstart Initiative, 1993, p. 1). Student-groupings bring children of different backgrounds, cultures, and interests together; consequently, students are exposed to a variety of people and ideas. Computers have this capability as well, with internet access to all parts of the world. Furthermore, a "bridge" is built between home and school environments when teachers include parents in creating a multicultural and meaningful environment by incorporating authentic activities into the curriculum. This can be achieved through internet and E-mail correspondence, or by involving families.

5. Feedback: Cooperative learning naturally creates a supportive environment for students when peers and teachers offer immediate feedback. Similarly, technology can respond
to students quickly, and in many creative ways (animation, sound, etc...). In addition, since computers can help teachers minimize time spent on record-keeping, students and teachers have more opportunities to interact.

4. Flexibility: Students learn in different ways. Cooperative learning empowers students to decide which strategies benefit them most. I.T. can also build metacognitive strategies, as computers are sensitive to the different learning paces of students, and can enhance learning by allowing each individual to control his/her search for knowledge. Both techniques can also be used across the curriculum, with multidisciplinary content. Teachers can benefit greatly from this flexibility, as they can develop more in-depth studies without changing the curriculum.

6. Multicultural Skills: As noted above, there are endless possibilities for incorporating multicultural perspectives through cooperative learning and computer environments. Children around the world can become partners in developing projects and in learning together. Our cities, counties, and countries are no longer isolated. These methods incorporate important global social skills into the classroom.

Research

Clearly, these two learning environments have the
potential for exciting results when combined! However, integrating them into the classroom requires more than assigning groups of students to use computers while working collaboratively on a project. Psychologists claim that cognitive interactions involve a variety of features, including conflict resolution, reciprocal peer tutoring, overt execution of metacognitive processes, and modeling (Light & Mevarech, 1992). Thus, it is important to understand the complexity of the interactions between cooperative learning and computers.

Mevarech and Light (1992) suggest that we need to look more closely at the verbal and nonverbal "features that characterize a three-way interaction involving two students and a computer as opposed to two-way interactions involving either a student and a computer, or a pair of students with no computer" (p. 276). The authors add, that though technology holds the tools to process information, students may use their opportunities in a cooperative setting differently than if they were learning individually.

Recent studies have looked at some of these interactions. In research on the social-cognitive behaviors of middle-class third graders, Nastasi and Clements (1992) measured the effects of Logo computer environments on the development of metacognitive strategies. The study involved implementing equal amounts of higher-order thinking activities, in two different I.T. conditions (Logo vs. word
processing). Subjects consented to being videotaped. This allowed observers to view and record target behaviors at a later time. Inter-rater reliability greater than 90% was achieved, and they were able to perform time-sampling data analysis and complete a behavioral coding checklist. One week following the study, children were interviewed individually, to measure their multidimensional metacognitive functions.

Results showed no significant differences between the two groups in the amount of collaborative interaction that occurred, significant findings were noted in the types of organizational activities each group demonstrated, with the Logo group spending more time reading plans, and the control group spending more time typing (Nastasi and Clements, 1992). Also, Logo students used their partners as sources of information more than their control counterparts did. However, there were no significant differences in the amount of time that each group used the teacher as a resource. There were interesting differences in conflict-resolution strategies, with the control group using more social negotiation, and the Logo students exhibiting cognitive resolution techniques. Both groups, though, primarily resolved their social conflicts using social dominance. The authors state that these results support the theory that certain types of conflict resolution, more than the simple occurrence of conflict alone, are what account for cognitive
change (Nastasi & Clements, 1992). But, it is unclear whether this is due to higher-order thinking, from experiences of perspective-taking, or from learning to monitor one's viewpoint through collaborative interactions.

Barbieri and Light (1992) looked at gender interactions as another variable effecting performance in cooperative computer settings. Subjects were 33 boys and 33 girls, age 11 to 12 years old, attending a state school in England. Children were assigned into three pair combinations: 11 boy-boy, 11 girl-girl, and 11 girl-boy. Subjects were videotaped during an activity session with a HyperCard computer program. A week following the study, all children worked individually on an equivalent task, and completed a questionnaire about their familiarity with and attitudes on computers.

Results indicated no significant differences among the pairs on levels of success attained during the first session (Barbieri & Light, 1992). Conversely, on the second session, the boys achieved greater success than the girls. Session 1 pair type was significantly related to session 2 success, with boy-boy pairs having significantly better scores than girl-girl pairs. On the student questionnaires, children from mixed gender pairs thought they could have worked better with another partner. Also, as expected, boys preferred boy partners, while girls preferred girl partners. None of the pair types thought they would have done better working individually. These factors considered, cooperation seems a
more powerful technique than individual instruction; however, negotiation skills can only be productive if both/all members of the group work within jointly constructed goals.

With cooperative computer learning, it is difficult to know what is occurring in the learner's mind because "each interaction is to some extent unique and will develop its own dynamic" (Atkins, 1993, p. 265). This already complex relationship is even more challenging to analyze when also considering that computers have endless multimedia applications (Adams & Hamm, 1990). Attempts have been made, though, to logically structure the design and implementation of educational technology and cooperative learning.

Models

In collaborative computer learning, students are either presented with an open-ended, large-scope problem, or given freedom in determining a problem on which they would like to work (Mevarech & Kramarski, 1992). There are different models for this approach. Atkins (1993) outlines a constructivist instructional design with the following sequential components: orientation activities to "tune in" the learner, advance organizers that preview the upcoming information, metacognitive devices to engage learners to process information, directly involving the learner in simulations with immediate feedback, and use of compare and contrast activities to analyze, summarize, describe, synthesize, and solve problems. Mevarech and Kramarski
(1992) designed another model, SOLVE, to organize the problem-solving process: Systematic analysis, Overall planning, Linking together, Verifying or debugging errors, and Evaluating and concluding.

It is appropriate to again stress that the effectiveness of these models depends on the teacher's implementation of them. As Mercer and Fisher (1992) explain, teachers typically attribute the successes or failures of I.T. to the software used, but in reality, it is the procedure used in a computer-based activity that effects the outcomes. They also note that through the "talk and joint activity of teachers and pupils ... the same software used by different combinations of teachers and pupils on different occasions will generate distinctive activities" (p. 354). This is an exciting development for educational reformers looking to modernize the classroom environment and improve students' learning.

Current Interventions

Cooperative learning and I.T. emphasize creative and challenging problem-solving. There are several programs that have implemented collaborative computer curricula with state-of-the-art technology, such as Apple Computer Inc.'s Apple Classrooms of Tomorrow (ACOT) research, and the AT&T Electronic Learning Circles Network. It is to those we now turn.

Apple Classrooms of Tomorrow (ACOT): The Knowledge
Express Project

Fisher, Wilmore, and Howell (1994) describe The Knowledge Express Project, which was the implementation of an innovative technological curriculum into a fourth grade classroom in the Greater Metropolitan Nashville School District, from November, 1988 to June, 1990. This project was sponsored by Apple Classrooms of Tomorrow (ACOT), which conducts educational research examining how immediate access to technology effects teaching and learning. ACOT immersed students' classrooms and homes with educational technology tools such as modems, video cameras, a CD-ROM player, flatbed and hand-held scanners, printers, laser disc player, hundreds of software titles, a 25 inch monitor, detachable speakers, and two telecommunications networks. The two teachers involved in the project had had 2 1/2 years prior experience using educational technology.

The structure of the Knowledge Express Project was to create a curriculum in which students would work in teams, on relatively extensive, cognitively complex, open-ended projects (Fisher et al., 1994), while also being held responsible for completing regular work assignments. There were five implementation stages to the Project.

The first phase required students to publish a classroom newspaper. Students identified the related jobs they would need to fill, and organized themselves into small teams to collect information. Teachers had allotted some time before
class began every morning for students to work on the newspaper. Observers noted that the students were extremely enthusiastic about the project (they cheered when the teacher announced it was time to work on the project), and began to extend their work into class time. Deadlines established for the paper were extended four times, which caused a discouraged attitude among students. However, they learned from their efforts, and decided to make the second paper more realistically focused, and set deadlines that were more practical as well.

Upon reviewing their experiences, the students noticed that some articles had longer "shelf lives" than others (Fisher et al., 1994). They also acknowledged that sticking to the deadline was more important than they originally thought. Clearly, these students showed an investment in the success of their product, and were straightforward when discussing their experiences.

The second phase, "technology week," occurred the following November. This phase gave students an opportunity to explore the capabilities of the technology in the classroom. Eight teams were developed. Each team worked for two hours a week to become "experts" at using a particular tool. They then made presentations to the class using the tools. Students showed creative applications of the technology.

The third stage of the Project occurred three months
after technology week. Students were required to compose a contract of their topic, and could choose to work in teams or individually. Most of the final products were presented traditionally, as either hand-drawn posters, or dioramas. Overall, the projects did not extensively use the technology, although one did use the Visual Almanac, and another used animated illustrations.

The fourth phase of the Project was a unit on health, taken from the district’s curriculum. Projects were presented in one of three ways: orally, using a student-made visual aide; written and oral, including guest speakers from the community; and dramatic production, either a play or puppet show.

Finally, in May, students were to reflect in writing on their knowledge about technology. This idea came from the students. They would create a book about their experiences for the students in next year’s class. The students worked cooperatively on this, and completed the books by June.

Fisher et al. (1994) suggest some conclusions for the outcomes of the Project. First, the teachers were frustrated in trying to allow students the opportunities to work on projects with the technology, because they were still required to meet the district’s curriculum requirements. Also, supporters of the traditional pedagogy were so strong that the ACOT classroom had to remain private. Thus, there is no way to examine how the peers of the participants viewed
the Project. Finally, the shift in classroom roles provided a means for students to excel in areas that they hadn’t achieved in before. Students were able to personalize leaning and make meaningful connections according to their individual interests. Teachers distributed their control to the students, which allowed students to take more responsibility for their learning, which sometimes led to disappointment as well as satisfaction.

In sum, The Knowledge Express Project was able to examine interactions in a technologically-immersed classroom. Findings suggest that much work needs to be done to incorporate I.T. in a manner that is non-threatening to meeting curriculum mandates if it is to be incorporated more widely in classrooms (Fisher et al., 1994).

**AT&T Electronic Learning Circles**

The AT&T Electronic Learning Circles Network is a highly interactive, cooperative strategy that allows six to eight groups of students and teachers, called “teams,” to communicate with other teams around the world (Riel, 1990). Integrated into the classroom, Learning Circles provides a means to reach a shared goal. The Learning Circles program occurs over four months, following this sequence of events: Forming the Learning Circle, Project planning by the classrooms, Accomplishing the task, Creating the publication, and Sharing and evaluating the publication.

This program develops cooperative learning at a higher
level. Children are able to interact outside of the classroom with other groups of students (Riel, 1990). Teachers continue to facilitate and guide students, just as is done in cooperative learning; however, their role, too, changes levels, because teachers actually become a member of the team.

There are many benefits of this program. First, this strategy is ideal for exploring topics that are often difficult to discuss face-to-face. Riel (1990) gives an example of participants who became aware that some of the students in their Learning Circle were deaf, after they sent their partner schools information on audiotape. There was immediate interest among the students in learning more about what it was like to be deaf. The deaf students were able to share their feelings with the partner school using the network; consequently, other students and teachers received very powerful first-hand narratives that they otherwise would not have been exposed to.

Another benefit of Learning Circles is its ability to provide a way for partner teams to share resources (Riel, 1990). For example, teacher participants can access ideas for curriculum by communicating with other teachers in the circle who may be teaching a similar topic. Students, too, can learn to use each other for information and ideas. Just as traditional cooperative learning enhances self-esteem through working together, Learning Circles provides
participants with both intrinsic rewards for successfully completing a project, and extrinsic recognition from peers.

With technology like Learning Circles implemented in the classroom, "teachers would not be the only educators in the classroom, they would be joined by visiting educators from all sectors of society. Students and teachers no longer need to be completely isolated from the adult community and our understanding of the term public education could be significantly altered" (Riel, 1990, p. 464). Just as individual societies are no longer isolated from the rest of the world, our classrooms have the potential to be connected to remote places. With the opportunity to communicate with peers from around the planet, students will be able to connect meaning with what they read and hear about those places by interacting with real people. As a result, they will naturally gain an understanding for different cultural perspectives, which can only benefit their own critical thinking skills and tolerance for other points of view (Riel, 1990).

A Review and Preview

After reviewing the literature, it is very apparent that technology has "the possibility of attaining simultaneous goals within the cognitive and psycho-social domains" (Mevarech & Light, 1992, p. 279), when combined with a constructivist pedagogy like cooperative learning. This
quickly growing, modern field is lacking in extensive research, and is in demand for answers to questions about the complex interactions between students, and teachers, and educational technology. It seems that the best way to discover what participants in this type of instructional design experience, feel, and perceive, is to evaluate their personal responses to the intervention. Thus, as supported by psychological theories, educational research, and effective projects that integrate cooperative learning and computer environments, the present research seeks to identify major concepts and issues as reported by students who are learning interactively with both peers and technology.
Methodology

The purpose of this research was to examine some of the psychological and educational interactions that occur when interactive computer technologies were combined with cooperative learning.

The hypotheses were:

H1: Overall, those students who had more prior experience working collaboratively in groups, will express more favorable responses about the activities than their peers who have had less opportunity to work cooperatively in the past.

H2: Students who had more prior experience working collaboratively in groups will display greater ease in using higher level thinking skills than their peers who have had less opportunity to work cooperatively in the past.

Due to this study's in-depth, qualitative nature, as well as its purpose to examine relatively new developments in the field of Education, specific hypotheses could not be formulated about the manner in which subjects would respond to the interviews. Expectations about the details of
subjects responses would defeat the purpose of the design of this research. However, more general research questions were raised:

RQ1: Did subjects look to their peers or to the technology resources for information? Why?

RQ2: Did subjects feel ownership over their learning? Why?

RQ3: How did subjects communicate in their groups? What helped their interaction together? What hurt their collaboration? Did the availability of technology make the subjects feel that their group was more/less coherent than it would have been without it? Why?

RQ4: What metacognitive skills were developed and/or can be transferred to another situation? Did the group interaction or the technology stimulate how the subjects learned? Why?

RQ5: To whom/what did subjects look to for feedback? What monitored their learning most (the investigator, peers, technology)? Why?
RQ6: How did the input from and interaction with peers who are different from a subject affect their learning strategies? Why?

Procedures

Each subject was separately brought into an unoccupied office and was reminded that they were participating in a study that looks at new ways to learn at school. The researcher reviewed subjects' rights to withdraw from the study at any time, restated that subjects' responses would remain confidential, explained that the project would not be graded, and stated that any work missed by being out of class would be made up, according to arrangements by the regular classroom teacher. Subjects were told that the project had three parts, so they were expected to attend all days that the research was scheduled. Then, each student was asked three questions (see Appendix B) in an individual, tape-recorded interview about general learning methods.

The following four 30 minute cooperative learning activities were organized and facilitated by the investigator, as developed by "The Great Ocean Rescue" (GOR) software by Tom Snyder Productions, Inc. (1993). The investigator tailored the activities selected to the age and interests of the subjects. Before the subjects met for the first activity session, the investigator gave each student a thematic worksheet that is included in the GOR materials. The worksheet was a blank map of the world, and subjects were
instructed to fill in the names of the continents and oceans, and to bring it back completed to the first group meeting.

Once all subjects completed the initial interview, they were brought into the school library as a group (equipped with a Macintosh computer, a laser player, and a television set) on the second scheduled session. Subjects spent this session and the next three sessions in two learning groups, maintaining regular classroom peer-affiliations. These "teams" were selected by the investigator through a stratified random sampling. Each team was proportionally representative of the classroom, according to gender, ethnicity, and the teachers' science ability ranking.

During the first session, the investigator gave the subjects a brief overview of the day's agenda, emphasizing that they should ask each other questions about the information in the activities before asking the investigator. Then, the investigator divided the subjects into their respective class-groupings (described above). At separate tables, each team made up a team name and decorated a sign with their name on it, that would be used in the rest of the sessions. Class A's team was the "Explorers," and Class B's team, "The Tigers." The ocean worksheet, handed out earlier, was used to introduce the topic and generate an opening discussion about oceans. The fifth grade at this elementary school had studied oceans earlier in the school year, so all subjects expressed that they found the worksheet enjoyable.
and non-threatening. The investigator then requested that each team come up with three questions about the ocean, which were then shared with the other team as the investigator wrote them down on a large piece of butcher paper. After the discussion was completed to the satisfaction of the subjects, the investigator had the subjects return to the chairs set-up by the T.V. and computer equipment, and showed the subjects the introductory movie to the GOR program.

The GOR program was designed for cooperative groups. Each member of the team became an "expert" in a certain field (Marine Biologist, Environmental Scientist, Geologist, or Oceanographer). Consequently, group members were dependent upon each other in order to find the right information to solve a Mission, and "spend" as little "money" as possible in the process. Prompted by the introductory movie, the investigator asked the subjects to think about which expert s/he wanted to be, to decide amongst themselves, and then to tell the investigator what they decided. Each subject was given an identity tag attached to a string to wear around his/her neck. This helped inform all participants of which expert each subject represented.

All subjects were eager to find out what Mission the investigator had chosen. Subjects viewed "The Case of the Pollution Pirates" two times. The first time was to give the subjects an overall picture of what they were going to be doing for the next couple of days. During the second viewing
of the mission, the investigator handed out worksheets and encouraged subjects to take notes. This first group meeting was almost over, and subjects would need to remember important information for the next meeting.

During the third session (second group meeting), the investigator showed the Mission transmission once again. The groups’ first task was to find out where the Pollution Pirates dumped the pollution cargo. To motivate the subjects, the investigator told them that if they could solve the Mission without spending more than $50,000.00, they would receive a prize at the end of the study. Subjects returned to their tables and were given a booklet (provided by GOR) that helped each expert find information to help the group make an educated decision. Teams also used a GOR worksheet to organize their ideas. While teams were discussing options, the investigator floated between the teams, answering questions and making sure that each subject understood the task.

Also during this time, the investigator modeled for the subjects how to use the technology equipment. This was done for each group separately, since it was critical to use time efficiently. In this manner, each subject could receive individual guidance. They were shown how to use the software to navigate the laser disc, which held additional relevant information on the topic. Then, subjects had an opportunity to explore on their own. Each team was allotted equal time
at the computer, and the investigator made certain that each subject had at least one attempt to experiment with it.

Before the end of this third session, the group was brought together and each team shared its ideas about possibilities of where the pollution was dumped. Importantly, they shared the reasons behind their conclusions. As a result, one team decided to change its choice. As a group, they then told the investigator what was decided, and the investigator played the video transmission that revealed the location. They were correct, and after an emphatic cheer, subjects were anxious to return the next day.

The fourth session (third group meeting) was similar in design to the third, except subjects were to decide on what type of pollution was dumped. This required them to make three decisions. First, they had to decide, as a team, which "scientific tests" to perform on the ocean water at the dumping site. Each test cost money, and teams would need to make their decision based on their hunches, and on which tests would assist them most in determining if the pollutant they suspected was the contaminant. Second, subjects were required to determine an order for which to perform the tests, so they could narrow down the possible suspected pollutants. This time, subjects quickly understood what their expert roles were, and quite confidently shared information from the materials with their teammates.

During this time, the investigator encouraged groups to
discuss the reasons for their decisions. Since there was a possibility of encountering difficulty when trying to convince the other team of their choice, once everyone met as a group for the final decision, the teams needed to have prepared solid explanations to convince the other team of their recommendation.

Once again, before the end of the session, the subjects met as a group and discussed their options. Subjects took their roles very seriously, and as a result, the Explorers changed their choices. Some subjects expressed alternate viewpoints, and others agreed; nevertheless, they were able to decide on two tests which helped them identify the pollutant on the first attempt. Needless to say, the eight very excited fifth graders were very ready to find out what their prize was.

Between the fourth and fifth sessions, both fifth grade classes, together, went on a four-day overnight nature-camp trip. Upon their return, they had much relevant information and stories to share, which the investigator incorporated into a discussion while reviewing and offering closure to what they had accomplished during the last three activity sessions. The investigator facilitated the group's dialogue on pollution and the ocean, and on finding possible alternatives for disposing of waste. Then, the investigator divided them one last time into their teams, where subjects (not in their "expert" roles) used a GOR worksheet to invent
new ways to reduce their own, everyday garbage. Before the session ended, the group met together as a whole and shared their thoughts. The investigator then rewarded each subject by handing out a bottle of bubbles to each subject as they were excused from the room. This was their prize for solving the mission with out spending more than $50,000.00, with which the subjects were very pleased.

The sixth (final) session was an individual, tape-recorded interview with each subject, during which the investigator asked seven questions about the subjects’ experiences in the study (see Appendix B). At this time, subjects were allowed to ask questions about the research, and give creative suggestions, opinions, and insights about the activities. Each of the final interview sessions were scheduled for 30 minutes, and were held in an unoccupied office or room.

Since the purpose of this research was to investigate and analyze how individual students perceive learning in a cooperative, computer environment, it was hoped that data collected would be the foundation for more specific queries in the future. The small size of the sample limited the accuracy that any quantitative statistical data would offer. Thus, results were analyzed in a manner that facilitates additional qualitative research in the future. Analysis was organized thematically, according to the two Hypotheses and six Research Questions proposed.
Participants

Permission to conduct the study was obtained from the principal of an East Bay elementary school. Subjects were eight students selected from the two different self-contained regular education, fifth-grade classrooms. One group of four students was from the classroom in which the teacher used cooperative learning regularly for academic instruction (Class B). The other group of four students was from the classroom in which the teacher used fewer cooperative learning group strategies (Class A).

The eight students were chosen by stratified random sampling within each of the two classrooms, according to gender, ethnicity, and teacher ratings of students' science aptitude level, with 1 being the highest possible score relative to a student's gender identification (see Appendix C).

All selected subjects were given a letter of informed consent to be signed by their parent(s) and themselves. If a parent or child had denied to consent, another subject would have been chosen and would have been required to fill out the form. This did not occur, and once all signed consent forms were received, a research schedule was arranged with the principal and the teachers.

Two subjects were absent for one session. A high-achieving boy from Class A missed the first activity session, and a lower-achieving boy from Class B was not present for
the third activity session.

Instrumentation

The investigator designed the open-ended interview questions based on the six characteristics that cooperative learning and educational technology share, and to seek answers to the Research Questions proposed by this study. This was a first step to finding answers for questions about what aspects of learning students find most beneficial, and served to help focus future research on the use of new, sophisticated educational technologies in the classroom.

During the interviews, the investigator changed the wording of the questions if it was felt that the question was not facilitating the type of response desired. Also, additional questions were asked of certain subjects if it was detected that s/he had more profound opinions or ideas about a particular question, and that the response to the supplemental question would give the investigator more insight into a subjects' perceptions.

The first three questions were used by the investigator as a pre-measure of the subjects' past learning experiences. Question 1 began the conversation by allowing the student to talk about something familiar. It also served as a means to discuss what learning/teaching methods were used in the child's classroom, and which methods s/he enjoyed for learning new things. Question 2 was an extension of question 1, to focus the subject on discussing only times that the
teacher used cooperative learning in the classroom. Finally, question 3 introduced the topic of technology, and asked the subject to explain where, when, and how s/he had used a computer up until that time.

The second set of questions, asked after subjects completed the activity sessions, helped subjects reflect on the activities and on their learning. Question 4 was an overall assessment of the study's topic and format. It asked the subject to rate the topic (oceans), the group structure (cooperative), computer usage, and the combination of the group dynamics at the computer. Responses to this question were elaborated upon in questions 5 through 10.

Question 5 investigated what resource the student used to research more information on the topic. Since the investigator's role was to facilitate and not give "correct answers," subjects had to choose between using the GOR computer software, worksheets, information booklets, or their peers, to learn more about the topic. Question 6 allowed the subject to express to what extent s/he felt involved in the decision making process throughout the activities. It also provided the subject with an opportunity to suggest a reason for experiencing this level of control.

Question 7 asked the student to explain how his/her group communicated, and to state possible explanations for why they interacted the way they did. Question 8 asked the subject to give his/her personal insight into how the
activities could be adapted into other subject areas. This question attempted to focus the subject to explain metacognitive strategies that could have been transferred.

Question 9 elaborated on question 8, inquiring about the part of the GOR activities the subject found gave her/him the best feedback. Since there were no "correct" methods for performing the activities, question 9 examined where the subject turned to understand concepts more clearly. Question 10 asked the student to describe his/her feelings about working with peers who are different, and if it helped or hindered their learning.

If the investigator felt that more information was needed from a particular subject, additional questions were asked upon completing these 7 questions. They may have addressed topics such as productivity, motivation/excitement, attitudes, what was learned, and self-esteem. However, these issues usually were adequately addressed through the questions in the second interviews, and the investigator generally did not need to probe the subjects for additional information.

Data Organization

Data collected through the interviews were organized into eight themes for a more thorough interpretation. The themes were determined by the major focus areas examined in this thesis, specifically, the two Hypotheses and the six Research Questions.
Overall, the interviews offered many rich insights into the way the subjects perceived their learning. When appropriate, quotes were supplied to emphasize relevant support for the results. In the transcriptions, "Q" represented a question being asked or a comment made by the investigator. "A" denoted an answer, comment, or response given by the subject.

All names were withheld from these reports, in order to protect the anonymity of the subjects who participated; however, general descriptions of certain groups and/or individuals were supplied to explain interactions or give further insight into a particular finding.

In this study, Class A was the group of subjects from the classroom in which the teacher used less cooperative learning strategies than the other. Class B subjects were from the classroom in which the teacher used more cooperative learning than the other.
Results

Data collected from the subjects, with regard to the hypotheses proposed, seemed to overlap between the themes, and were therefore discussed together below.

Theme One: Cooperative Learning and Favorable Response

(Hypothesis 1)

H1: Overall, those students who had more prior experience working collaboratively in groups, will express more favorable responses about the activities than their peers who have had less opportunity to work cooperatively in the past.

Theme Two: Cooperative Learning and Thinking Skills

(Hypothesis 2)

H2: Students who had more prior experience working in groups will display greater ease in using higher level thinking skills than their peers who have had less opportunity to work cooperatively in the past.

Although, in general, Class A's classroom teacher used less cooperative learning with the students, she created a very positive learning environment where, as one female subject reported, there were "no put-downs." When the class was divided for group work, it often was separated into halves with each side of the room as a team. One subject from Class A reported that all four team members in this study were from the same side of the room, and had worked
together before.

At some point, all Class A subjects expressed that they enjoyed investigating things and liked the topic, their group, and using computers. When asked, "what's your favorite thing to do when you're learning something new?" one male subject replied, "find out myself!" This clear excitement for learning in general, and for enjoying activities that involved investigation, was true for all Class A subjects. In fact, three of the four said their favorite subject in school was math, a subject that requires the learning strategies they self-reported they use often.

In addition, all Class A subjects reported using friends or siblings to help them study for tests, or to help answer questions about homework. This learning style was clearly reflected in responses given in the post-activity interviews. Subjects reported that they were able to work out group conflicts and use problem-solving strategies that best suited themselves personally, as well as a means for making decisions as a group.

However, Class B clearly showed a more developed understanding of what was expected in group work situations. One girl described her teacher's teaching style when the class was doing group work: "Um, usually she wouldn't let us ask her questions 'cuz we would have to find it in our packet we got, and we'd have the answers from there." The other Class B girl said that when the students work on math in
groups, they are required to ask questions of the other kids in the group first, before going to the teacher. She said that the assigned groups were switched every month or so, and that the students can sometimes work on a test with a partner, or do a reading project with a group. These descriptions correspond with some of the basic components of cooperative learning discussed earlier.

Although Class B's expectations of cooperative learning were more developed than those of Class A, all Class B subjects described feeling some level of frustration with other group members, and that four people in one group were too many. Class B tended to use different learning strategies from each other, which seemed to create group dynamics with which they did not cope well.

For example, when asked to rate between 1 and 10 (10 being the most positive rating), the experience of working with their group on the activities, the high-achieving Class B male gave a rating of 8 and explained, "because, like, if you wanted to write something down, if somebody else doesn't agree, you have to change the answer, so everybody could agree." When asked why his favorite subject is math, he said, "because I'm good at it." When learning new material, he said that he understands it right away, and studies by writing down all he knows, and then would call a friend if he had any questions.

Another subject (female), said that she would rather
have been alone some of the time, since she likes to organize her thoughts before discussing them with other people. She reported her favorite subject was reading.

The other female in Class B explained that she liked to learn shortcuts in math problems, and thought word problems were too hard. She continued, stating that she liked it when the teacher wrote down the steps, rather than doing the puzzles herself because she "just want[ed] to get on with it." She described herself studying for tests by memorizing the information.

In summary, Class A showed greater enthusiasm for the GOR activities, and for the cooperative group learning environment, than did Class B. Class A also displayed greater ease in using higher-order thinking skills to solve the problems posed to them, and was more successful in using collaborative team skills. Therefore, it seems that both hypotheses were not confirmed, and that Class B, the group with more cooperative learning classroom experiences, did not report having more favorable responses, or using more critical thinking skills than Class A. In fact, it seems the opposite was true in this study.

Theme Three: Resource Skills (Research Question 1)

RQ1: Did subjects look to their peers or to the technology resources for more information?

All subjects in both Classes stated that they used either the expert booklets, the computer references, or their
peers before asking the investigator any questions. Three of the four students in Class A reported that they looked in their booklet first. One boy stated that he looked to the book in order "to find it out" himself first, and then would tell the others what he learned. Both girls in Class A said that they enjoy investigating and figuring out mysteries, and thus, turned to the booklets as a reference. The fourth member of Class A missed the first activity session. He said "I think it just took me that first day, to get used to...," and asked the other group members "what [they] were doing" before looking for information himself in the booklet.

Three subjects from Class B also tended to look in the booklet first for information, before using any other method. Two students, one boy and one girl, reported integrating the information they found in the book with other information from group members, and/or the laser disc material from the computer.

It is interesting to note that subjects' statements on the pre-activity interview question regarding this topic were similar to how they described their most desirable resourcing method for these activities in the post-activity interview.

Theme Four: Ownership (Research Question 2)

RQ2: Did subjects feel ownership over their learning?

There was a clear relationship between ownership and learning style. Subjects who felt they contributed to their own learning, as well as to the success of their team during
the GOR activities, showed a tendency to participate more. For example, both boys from Class A reported that they usually participate a lot in their regular classroom activities, and felt that "everyone had an equal part." One felt very confident about participating a lot because generally, when he was working with a partner, the "partner probably participates less than [he does]." However, as one girl from Class A explained, it was not always easy: "I said some things or stuff like that, and sometimes they were talking too, so they didn't hear me, and sometimes it hurt, really bad."

A Class B girl said that the work was pretty equal except "that a lot of times people would like start, like getting carried away with something that had nothing to do with what we were doing." Interestingly, the other girl from Class B said she would have rather been alone than in a group "'cuz [she] can think better, instead of saying it out loud 'cuz sometimes [she] can think of something and it's hard to describe it out loud." She continued to explain that she didn't feel very involved in what her team was doing:

A: "Everybody was just shouting out the answers."
Q: "Why do you think they were shouting?"
A: "They were excited?"
Q: "And that's not your style...?"
A: "No."
Q: "So you'd kinda step out of it?"
A: "MmmHmm."

For one boy in Class B, the group environment did seem to make a difference:

A: "I just feel very involved 'cuz I got, I got a say in it, and lots of the times I don't."

Q: "What do you mean, lots of the times you don't?"
A: "Um, let's say in school, there's a lot of people there, and then the teacher can't pay attention to everybody. I get to participate more in small groups."

In the pre-activity interview, this subject told the investigator that he calls his friends for non-learning related activities, such as when he leaves his "math book at school or something like that," but also added that when working with a partner, he gets to say, "ha, ha, I figured it out first."

Theme Five: Communication (Research Question 3)

RQ3: How did subjects communicate in their groups? What helped their interaction together? What hurt their collaboration? Did the availability of technology make subjects feel that their group was more/less coherent than it would have been without it?

There was a clear difference in the communication skills displayed and reported between Classes A and B. Class A subjects expressed that there was equal participation among its members, as well as much use of important communication
skills such as listening, compromising, cooperating, conflict-resolution, and information management. For example, note the following interview excerpt from the high-achieving boy:

Q: "How did you communicate with each other?"
A: "We didn't talk real loud so the other group couldn't hear, we worked together.
Q: "What do you mean?"
A: "We didn't have like one person do like the whole thing. Everybody had an equal part."
Q: "Did that help you learn?"
A: "Yeah..."

One of the girls explained that they "got along...because [they] shared ideas and stuff." In addition, the other boy explained how he thought the team got along:

Q: "Beside the fact that you knew each other before, what other kinds of things helped you get along?"
A: "Um, listening to one, to one, each other."
Q:" How, where, how, where did you guys get such good listening skills?"
A: "We have to pay attention a lot in class."
Q: "Oh. [Laugh]. So you've had practice."
A: "Yeah."

Class A also reported a genuine enjoyment of the topic and of their team members, which some subjects felt helped
them get along and communicate better. As one girl explained, their classroom environment is one in which "put-downs" are not acceptable. The other girl explained the benefits of working in a group:

Q: "Did it help to have people with different ideas?"
A: "Yeah, cuz then you could narrow it down and find out what it is and then it would be funner 'cuz you'd have to investigate even more."

Although Class A did mention having a couple squabbles, most of their comments were about positive experiences. One boy explains how he helped to resolve a situation when the girls were fighting over decorating their team sign:

Q: "How did you resolve that?"
A: "Split 'em up! One on one side of the table, the other on the other side."

Q: "Who split them up?"
A: "Me!"

Q: "Did that work?"
A: "Yeah, they didn't have to look at each other, but I don't know why I did that. I got kicked by [one of the girls]!"

He continued, explaining that during the next session, they got along much better and there was no yelling.

On the other hand, Class B reported more significant incidents, which hindered their communication as a group, or, as one girl explained, were a result of poor collaboration
skills:

A: "I got along with everybody, but, um, like, [the other girl] and [one of the boys], they didn't get along....so."

Q: "What happened?"

A: "I don't know, it's just like [the other girl] did not agree with [one of the boys] sometimes."

Q: "Oh. How did they resolve that?"

A: "They just um, were quiet, I guess... they were just tired of being mad so [the boy] just put down his answer. [The other girl] just let him."

She added later that the boys were talking about football a lot, so they didn't listen to the other girl's idea for one of the answers (which, as this subject later said, turned out to be the right answer).

Class B also reported using less higher-order thinking skills and cooperative learning skills. One girl said that when they were deciding on an answer to present to the other team, everyone looked in everyone else's books to learn more about the question, instead of using each other as an expert for advice.

Although there seemed to be a gender division in both teams, this separation was more prevalent and had more of an impact on Class B's communication. The boys said they complimented each other, but did not offer support to the girls because the other boy worked the hardest. The girls
reported having conflicts with the boys, and one girl even suggested limiting the teams to 3 members in the future because she did not like working with one of the boys, and found that the group "worked better" when he was absent for one session. However, she also said that the group experience probably went well because they already knew each other, and they all really wanted to get a prize.

There was no mention in either team of the technology having either a positive or negative effect on the team's communication skills.

**Theme Six: Flexibility (Research Question 4)**

RQ4: What metacognitive skills were developed and/or can be transferred to another situation? Did the group interaction or the technology stimulate how the subjects learned?

The investigator asked each subject to use their experience in this type of cooperative computer environment to create a problem (related to their favorite subject in school) for a hypothetical group to solve. Most subjects responded quite creatively to this interview question, offering ideas that clearly reflected their understanding that this type of activity can be transferred to other subject areas. It seemed that in this particular study, subjects were affected more by their group's interaction than by the technology. However, they were able to begin to think of some ways to incorporate other learning methods besides
using technology in their projects, which demonstrated their understanding of the computer as an instructional tool.

For example, one girl from Class A, whose favorite subject was art, said she would have her group create a mural, and "everybody would do a section until it was finished." When asked how she would choose one idea from the many they may suggest, she said that they would need to "cooperate, maybe make something else. Like put 2 things together. Like a fish tail on a turtle or something like that."

One of the boys from Class A pondered the issue of group size and take-home assignments like the ones from the GOR activity. "Not sure if you had a group of 9 kids that they'd all do it. Maybe 4, and maybe all if they had to bring it back." He eventually decided that 4 was a good size for a group. Since math was his favorite subject, he described a math activity he'd create for a group, using the same characteristics of the GOR. The group would have to find out how many barrels of junk were dumped into the ocean, according to real-life data.

Q: "What kind of information would you give them?"
A: "Um, I'd give 'em...I'd give 'em a walkie-talkie to go stand somewhere near to the coast... out to the water, to count how many barrels there were underneath the sea!"

One girl from Class B, whose favorite subject was
reading, decided she would have a group of 3 students read a book and do a report for the class by dividing the work equally. "Actually, two of the people could write, 'er if they wanted ta', um, we would do it on a rough draft first. Then whoever had a computer at home would get ta' do it on the computer."

The high-achieving boy from Class B came up with a scenario for a math mission for his group to solve:

"Oh! Like, um, there was this big pizza, okay? And then, everybody starts eating, like there was 4 people, okay?. And then, there was 32 pizzas!..Okay? So each people can have 8 slices. Okay. So. When they were eating, somebody didn't get 8 pieces. And they're trying to find out what happened to the rest of the pieces."

The other Class B boy's favorite subject was social studies, and in particular, World War II. He created a learning structure for his hypothetical group:

Q: "Say it was a group of 12."
A: "I'd probably have to split 'em up in half... so they all wouldn't um... get into a big fight."

When the investigator asked how he would keep their attention if they did not seem interested, he said that he would make "wise cracks" to get their attention. He explained that his goal for the lesson would be to teach about how World War II originated. When asked how he would accomplish his goal, he
said he would bring in a video, make a list of things they learned, ask questions to see what they understood, and help them if they didn't understand things. This procedure was similar to the one used in this study.

**Theme Seven: Feedback (Research Question 5)**

RQ5: To whom/what did subjects look to for feedback?

What monitored their learning the most (the investigator, peers, technology)?

There was quite a discrepancy both within and between teams, regarding where their most helpful feedback came from. Four of the subjects (the high-achieving boy and the high-achieving girl from Class A, and both girls from Class B) said that the investigator played a key role in guiding them in the right direction. One girl from Class A said it was because "you told us, 'listen to this part of the movie'." One girl from Class B said she would not want to only use the books and the videodisc information.

Two subjects, a low-achieving girl from Class A and a high-achieving boy from Class B, said the videodisc "movies" helped most. As the boy explained, when choosing a location at which he thought the pollution was dumped, he was the first subject to request to see the transmission again to make sure that

"when 'B' was at this narrow place, it was like this thin, you can't circle it too good, so we thought maybe that this was, um, be the place, and there would be a
lot of salt there, and there would be a lot of animals 'cuz you know, the shore. And there would be a lot of people swimming."

The remaining two subjects, the lower-achieving boys, from each team, relied most on group members to keep them on track because, as the Class A boy explained, "they said, 'you should look at this, instead of looking at that'."

**Theme Eight: Multicultural Skills (Research Question 6)**

RQ6: How did the input from and interaction with peers who are different from a subject affect their learning strategies?

There did not seem to be a strong influence on any of the subjects' learning because of the cultural background or ethnicity of a subject's fellow teammates. As members of Class A said, they had worked together before, so it felt comfortable, and it was "great to work with other people." One girl said, "I like working in groups and stuff. It's cool."

Class B also said that they were "used to it from working in a group in class," and that it did not feel strange. One Class B girl, however, did note the importance of personality compatibility: "well it didn't really matter about anything like that. I just [?] about their attitude and how they can work with you."

In summary, although the hypotheses were not confirmed, there were many interesting observations made due to the
thematic focus of the interview questions. Class A, despite their less frequent classroom experiences with cooperative learning, seemed to report more positive descriptions of their group learning with the GOR activities than did Class B. Class B, on the whole, seemed more frustrated with the group situation, despite their past experiences with cooperative learning. The role of technology in the activities, for both groups, did not seem to be a major factor in their learning, however it was clear that the subjects were interested in its role, and would have liked to have had more time using the computer and laserdisc.
Discussion

This study used the activities and materials from The Great Ocean Rescue in conjunction with a curriculum plan that was made grade-level appropriate and relevant for the group of students who participated. As with many curricular activities, the technology served only as a guideline for the curriculum topic being discussed. Since educational technology is such a flexible tool, educators have the ability to contribute their own creativity in order to reach their main goal, which is teaching curriculum in a manner that will maximize their students' retention of the information, and enhance the material already being taught.

The students in this study had studied oceans and marine life during the fall of the 1995-1996 school year. They showed a lot of enthusiasm and interest in learning more on the topic in this setting. This may have been due to many factors such as a genuine personal enjoyment of the subject, the excitement of being involved in a study of this kind, looking forward to using technology, a heightened interest about oceans due to their classroom teacher's influence, or having the opportunity to leave the classroom in order to participate in this study.

The subjects' previous knowledge of the topic could have influenced the results and integrity of the study dramatically. The accuracy of the students' confidence and responses regarding the topic may have been reflections of
past activities or experiences in learning the material, rather than independent, novel reactions to the Great Ocean Rescue curriculum. Also, the participants' previous knowledge may have given them more motivation because they were already comfortable with the material and could focus more on the issues of group dynamics and technology. Thus, the general setting of "oceans" as a topic, may have served as a comfortable backdrop for them to explore new methods of learning.

Overall, there were three major influences on how participants perceived their learning. First, within-group dynamics set an important tone for the students, as their individual personalities and learning styles affected others as well as themselves. Second, the role of the investigator as a facilitator rather than an instructor, and the many places the students could turn for feedback, including technology resources, conveyed a particular message about student ownership of learning. Finally, and possibly most important, were the expectations for success that the students felt, and how that had been conveyed to them in the past by their classroom teacher. This study was just a brief look at how all these various factors, when combined, effect students' learning. However, it is this investigator's belief that the long-term, consistent messages students receive from teachers and parents about their progress, personality, and responsibilities are what help students most in developing into active, interested learners.
The members of Class A clearly displayed more uniformity with regard to these factors than did Class B. During the interviews, they expressed having similar study habits and learning styles. Three of the students’ favorite subject was math, the fourth was art; however, they all enjoyed investigating, working in groups, and friendly competition. When they needed help or had a question on their homework, they all explained that they would ask a sibling or parent or call a friend. They all valued their education and did not seem to give up easily.

They worked well as a team because they had worked together before in their classroom. This is interesting because as they said, they would not have chosen to work together if they could choose any group for themselves, but they knew each other well enough as people, to know what way to best interact with each other. After these subjects were chosen, their teacher mentioned to the investigator that all of these students had exceptional skills and would be a great group together. This class followed the "no put-downs" rule very strictly, which was obvious by the way these four subjects interacted with each other. They did not have as many classroom cooperative learning experiences as the other class, but they understood what it meant to listen to each other because it was a part of their behavior, and what they were expected to do everyday.

On the other hand, Class B students had very different learning styles from each other. One girl preferred to work
alone, one boy enjoyed group work, the other boy liked attention from goofing-off and had a hard time staying on-task, and the second girl said she enjoyed being in groups, but disliked puzzles and logic, and preferred using "shortcuts," or the teacher giving her the correct answers to finish an assignment. Although they had been in many different cooperative learning groups in their classroom, their personality differences disrupted their potential for reaching a unified group goal, and for avoiding a conflict.

However, individually, they were still able to find the information they needed to complete the activity. Even though each student's individual preference for resourcing information was different (one student chose to look in the pamphlet, another asked a fellow teammate to help, etc...), they were able to pull together to present their decisions to the other group. This demonstrated the potential for every student to find a comfortable means for finding information in a cooperative learning environment such as this.

Overall, the energy displayed in the Class A group was much more positive and productive, and seemed to have a very strong influence on how much they enjoyed the activities. Clearly, the students' skills, personalities and learning styles played a major role in determining their success as a group. Although it is impossible to know the interactions that will take place amongst any given learning group, these factors should be considered when creating a team, as they are crucial for its success.
Certainly any experience with others is a chance to build interpersonal and communication skills, and there are many times in which we do not have a choice as to whom we work with; however, there may be times when too many differences can harm a chance for group members to learn or succeed because the energy becomes too tense, confusing, or confrontational. As this study shows, even those with prior group experience, if not in a positive, nurturing environment, will lack the ability to interact with others. On the other hand, those who "live" in a positive place with chances to learn positive things about others with whom they share the space, will take on a new challenge using their energies together because they understand that their positive interactions with others will help them to succeed individually and collaboratively.

The facilitative role of the investigator was crucial to the participants' learning in this activity. There were no "right" answers, and therefore, this facilitative role was very different from that of a "traditional" teacher. Students' questions were answered with another question or comment that directed their investigation without solving the problem for them. In this way, subjects were guided to find the answer on their own, possibly leading to better internalization of the material.

For Class A, this style of teaching seemed to be welcomed as a challenge as if to solve a mystery. Many times they would ask the investigator a question, and before a
response was given, one of the group members would take on the challenge of finding the information to answer the other person's question. The facilitator's role was indeed just that - a guiding source to keep them moving and understanding what was required of them, but not a source for retrieving information about a specific task question on the material. Class A understood that they were there to help each other solve the mystery and took that job seriously, divided the work equally, and fed off each others' energy to reach their goal.

Class B did not seem to react the same way to this facilitative leadership role of the investigator. Only the high-achieving boy in Class B was productive in this setting. Interestingly, the other students, since they had different learning styles, were drawn to him as their "group leader" from whom they could retract answers. The high-achieving boy began the group sessions with the sheets of paper and pencil in his hand. He appeared to enjoy the role his group gave him, and did not hesitate to give them the answers they were looking for.

In fact, at one point, he became quite comfortable in his role. One of the girls wanted to write her answer down on the activity sheet, and he basically ignored her request for the pencil and wrote his idea down instead. The investigator observed this, and intervened by asking him why he didn't let her use the pencil. He replied by saying that his answer was right and hers was wrong. It is possible that
this type of interaction is common between him and his peers. In this type of activity, though, where each member is responsible for a category of information, not all of the students have the opportunity to share their information because of their perceptions of themselves and each other.

With so many different means for receiving feedback in this environment (peers, facilitator, technology, informational booklets), students have more alternatives for finding information and support. This, in turn, allows students a greater potential for learning and success. This is certainly not an end-all approach for teaching students information, but it does, however, provide more opportunity for students to find a comfort level among their different needs and learning styles.

**Recommendations for Further Research**

This study found some very interesting factors in cooperative learning computer environments. However, future research in this area should maximize the power of these findings by conducting the research over a longer period of time, and at a more strategic time during the school year (not in May or June). With more time available, the researcher could incorporate more real-life learning applications, such as a field study. The subjects also commented that they would have liked more time to explore and work on the activities.

It is recommended that the power of group research on the Internet be explored, since those skills are now crucial
to a student's success in the real world. Students should also have more of an opportunity to explore the technology, use it for assistance in finding information, and possibly develop their own activities for their group members using what they have learned already. Other technology-related group activities such as creating a business with word processing, spreadsheet data, and e-mail access, or developing games for peers using the computer as a tool, could be examined as well. While problem-solving using real-life challenges, students can build important socialization and computer skills.

In the current study, metacognition was looked at through one interview question. This resulted in very creative answers from the subjects, who for the most part could relate parts of the GOR activities to other areas of study. With more time, though, there could be more explanation, training, and utilization of metacognitive learning strategies to test the transference of the skills learned. If, for example, the subjects were required to actually create a challenge for another group after solving a problem similar to the GOR, more metacognitive themes may be displayed because the students would have to put into action what they had previously experienced.

Future research should account for a subject's personality and learning style. Classroom teachers have the advantage of knowing their students well. They are usually able to determine what groups would be productive, and have
the choice to switch group members if so desired. The goal of this type of research is to give information to educators about the complex factors involved in cooperative learning environments. Thus, the research should be reflective of the process that real classroom teachers make in selecting learning groups. This could require adding another characteristic to the sampling pool, or having the students change groups halfway through the study.

Another characteristic that was important for this study, and should be examined further in the future, is the role of positive environments in learning. Class A was an example of how students with positive social skills could succeed as a group despite not having much cooperative group experiences. They were expected to behave a certain way, which was the powerful factor in their interactions. By constantly using positive communication skills (and metacognitively teaching them), a facilitator could also foster productivity, good study habits, and self-esteem in students.

Finally, with more time available in the study, there could be more access to technology. "Access" could refer to more time at the one computer, or more computers set-up in the room; however, in cooperative learning with computers, it is this investigator's belief that there should be no more than one computer in use per group. Otherwise, the interaction being investigated changes dramatically.

In conclusion, just as children have different ways of
learning, teachers have different styles of teaching. Successful educational technologies have the flexibility to be adapted to the optimum teaching/learning environment for a specific purpose. Likewise, group structure needs to reflect the learning needs and goals of its members. Only with more research will we find how the complexity of these two components, computers and cooperative learning, and their many inter-related characteristics, can be managed for success in a classroom. This investigator hopes that this study can be a starting point from which we continue that quest.
References


Instruction, 2. 155-159.


National Education Association of the United States.


Appendix A

THE LETTER GIVEN TO PARENTS
AND THE CONSENT FORM
May 10, 1996

Dear Parent,

Hi. I am a graduate student in the school of Education at California State University, Hayward, and I am writing to request your permission for your son or daughter to participate in a research study. The project will take place at . The focus of the research is on the positive academic and social effects of using computers in student learning groups, and asks for your child’s personal description of the experience.

The study will take place during 6 sessions of 30 minutes each, over 2 weeks. There are three parts to the study. In the first session, your child will be tape-recorded during an interview about general learning methods. The middle sessions will consist of educational group activities using a highly acclaimed interactive computer program. The final session will be a tape-recorded, closing interview about your child’s experience with the activities. Since the children may be participating in the study during class time, Miss Kistler has agreed to make arrangements for providing make-up work.

Although there is minimal possibility that your son or daughter may find some of the interview questions bothersome, this is a good opportunity for your child to express his/her thoughts and opinions on important educational issues. Each child has the right to withdraw participation from the study at any time, and can be assured that names will remain confidential when results of the study are analyzed and reported.

Any further questions about this research project may be addressed to: The Office of the Associate Vice President, Faculty Affairs and Research, California State University, Hayward, California, 94542 (telephone no. (510) 885-3022).

IF YOU CONSENT TO HAVE YOUR CHILD HELP WITH THE STUDY, PLEASE SIGN THE ATTACHED FORM AND RETURN IT TO . If you have any questions or further concerns, please feel free to leave a message for me at the school.

Thank You,

Angie Frieden
Dear Angie,

I have filled out the information at the bottom of this page, and will retain the attached letter for my personal records. I have discussed the contents of the letter with my child, and I understand that my signature below shows that I agree to have my (circle one:) son/daughter, (child’s name:) ____________________ participate in this educational study on group work and computers. I understand that my child may withdraw participation at any time and his/her name will remain confidential when the results are analyzed and reported.

If I have any further questions about my child’s participation, I will contact you through The Office of the Associate Vice President, Faculty Affairs, at California State University, Hayward, or at your home, as per the phone numbers listed in the information I received.

DATE: ____________________

CHILD’S NAME: __________________________________________

TEACHER: __________________________________________

MY NAME: __________________________________________

MY RELATIONSHIP TO THE CHILD: ______________________

MY SIGNATURE: __________________________________________

CHILD’S SIGNATURE: __________________________________

PLEASE RETURN THIS PAGE TO YOUR CHILD’S CLASSROOM TEACHER AS SOON AS POSSIBLE AS PROOF OF YOUR CONSENT
Appendix B

INTERVIEW QUESTIONS

Pre-activity:

1. [GENERAL LEARNING METHODS]
   - What is one of your favorite subjects at school?
     - Why?
   - What activities do you do in that subject?
   - How does the teacher help you learn new things?

2. [EXPECTATION, PAST EXPERIENCES]
   - Can you tell me about some times that you've done work in groups at school?

3. [COMPUTER USE]
   - Can you tell me about some times that you've used a computer?
     (either at home or at school)

Post-activity:

4. [OVERALL EXPERIENCE]
   - On a scale from 1 to 10 (10 being the best), tell me how much you liked and didn't like:
     a) the topic?
     b) working in a group. Why?
     c) using the computer. Why?
     d) working in a group with the computer. Why?
   - If you were to do this activity again, what would you keep the same, and what would you change?

5. [RESOURCES]
   - To find out information, when did you use your peers? The computer?
   - Which did you use more?
   - Why?
6. **[OWNERSHIP: COMPUTER AND PEERS]**
   - How involved were you in making decisions? (Did you make a lot of decisions during the activity?)
   - Why do you think you
     a) participated so much?
     OR
     b) didn’t control a lot of the decisions?

7. **[COMMUNICATION SKILL]**
   - Can you tell me about how your group interacted? (How did people act toward each other?)
   - Did you get along most of the time or did you argue a lot?
   - Did you resolve any problems you had? How?
   - Were there some ways that you helped each other? How?

8. **[FLEXIBILITY, ADAPTABILITY, ADJUSTABLE, METACOGNITIVE SKILLS]**
   - How do you think that this activity could be used for other subjects in school?
   - Did it help you to learn best? (Did it fit your learning style?)
   - Which helped you learn at the best pace (not too fast, not too slow), the computer or your peers?
   - Did that seem to be true for the other kids in your group?

9. **[FEEDBACK]**
   - How did you know how you were doing? (Who or what let you know that you understood the lesson, me? Your peers? The computer?)

10. **[MULTICULTURAL]**
    - Can you tell me about how it felt to work with kids from different backgrounds from you? (Was it normal? Different?)

*** Do you have any other comments or questions that you’d like to talk about?

*** Also, to integrate into the questions?
(productivity, motivation/excitement, attitudes, what was learned, self-esteem)


Appendix C

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<th>Students Selected</th>
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<td>Subjects</td>
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