CHAPTER 3

LITERATURE REVIEW

The purpose of this chapter is to discuss some of the research related to technology integration in enhancing higher order thinking, acquisition of content, cooperative and collaborative learning and teacher role. Specifically, the chapter will review research related to the following areas:

(1) Computers enhancing learning and thinking;

(2) Cooperative and collaborative learning; and

(3) Teacher role.

Computers Enhancing Learning and Thinking

The computing era for instructional purposes can be divided into the mainframe and microcomputer era. According to Robyler, Edwards and Havriluk (1997), mainframes first appeared in the instructional scene in 1950 when computers were used to train pilots at MIT in a simulated environment. Subsequently, in 1959, mainframes were used in schools when the IBM 650 computer was used to teach binary arithmetic to New York City elementary school students (Robyler et al., 1997). During this time many key projects emerged under the sponsorship of major computer companies such as IBM, Digital Equipment Corporation, Computer Curriculum Corporation (CCC) and Control Data Corporation (CDC), all working in tandem with Stanford University, University of Illinois and Brigham Young University. Some of the more significant outcomes of such collaborative efforts were the emergence of authoring programs to create courseware or computer- assisted instruction (CAI) titles. These included

Coursewriter, which was designed for the IBM 1500, and instructional systems such as Programmed Logic for Automatic Teaching Operations (PLATO) and Time-shared Interactive Computer-Controlled Information Television (TICCIT). With the advancement of information technology, instructional computing shifted its focus from mainframes to microcomputers and in 1977 the first microcomputers came into schools in the United States of America (Robyler et al., 1997).

At about the same time, the computer literacy movement came into being, whereby educators felt that students should be taught about computers. Courseware titles multiplied as teachers began experimenting with simple programming languages to create computer-based titles. As a result, many new authoring systems emerged such as Hypercard and Linkway. This resulted in the computer-assisted-instruction (CAI) revolution (in the mid 1980s) whereby the computer was seen as a tool that could help teachers improve the students' learning. However, Papert (1980) was not happy with the extensive use of the computer for drill and practice which did not challenge learners' minds. He proposed Logo as a programming language that could allow learners to think and direct their learning.

Gradually, as computers became more popular in the classrooms, the use of microcomputers advanced from stand-alones to networked-based systems. As a result of this, the integrated learning systems (ILS) and networked systems came into being (from about 1988-1991). ILS offered more advantages than just saving cost. The ILS could be programmed in such a way that managing, tracking and reporting of student progress could easily be done on a central computer. However, ILS were still designed for the acquisition of basic skills. But when curriculum trends moved toward methods that were less structured and teacher-directed, companies began to respond to this need. The most recent networked systems offer arrays of software tools, lessons and media that teachers may integrate in many ways. These systems resemble the original ILS technically, but they differ in curricular approaches. Some refer to these systems as "multimedia learning systems", "integrated technology systems", or "open learning systems". Open learning systems have been characterized by the intense use of the Internet for web-based learning (WBL). The heart of WBL is the use of a web browser like Netscape or Internet Explorer.

The historical analysis shows that the use of computers in the classrooms has largely been influenced by the technology available at that time and the existing learning theories. However, what has the literature informed us about the effects of computers on learning? The following sections will present systematic reviews and meta-analyses carried out, as well as individual studies conducted on computer-based instruction (CBI), in elementary and secondary schools as well as at the college level.

Early reviews conducted by Vinsonhaler and Bass (1972) and Edwards, Norton, Taylor, Weiss and Dusseldop (1975) concluded that CBI was effective in raising achievement scores and reducing the learning time for various educational levels and in various subjects. However, more rigorous analyses were carried out in the form of meta-analyses where quantitative methods were used. One of the pioneers was Hartley (1977), who reported that student achievement improved for mathematics education in elementary and secondary schools using CBI. Subsequent meta-analyses carried out mainly by the Kuliks gave a clearer perspective of the effects of computers on learning. In this respect, a meta-analysis of 48 studies on five different types of computer applications — drill and practice, tutorial, computer-managed instruction, simulation and problem solving — conducted by

Kulik (1983a) showed that students from the CBI class received at least better test scores than did students from the control class. The average effect of CBI in the 48 studies revealed that student test scores increased from the 50th to the 63rd percentile. Other meta-analyses carried out on secondary and college students (Kulik, 1983b) and on adult learners, (Kulik, 1986), showed the following results: (a) CBI increased student achievement scores; (b) CBI reduced the learning time; and (c) CBI promoted positive attitudes towards learning. However, in a more recent meta-analysis, Christmann (1997) compared the academic achievement of secondary students during a 12-year period who were instructed through traditional methods, supplemented with CAI or CAI alone. He noted that the effect of CAI on academic achievement declined. Thus, it can be concluded that the meta-analyses carried out on CBI studies by the Kuliks show positive effects of computers on K-12 as well as adult learners. However, studies of a significant effect of CBI on learners are inconclusive.

In the late 1980s, courseware programs witnessed higher-levels of sophistication in their design when more powerful coursewares incorporated the information-processing theories into their production (Yazdani, 1987). Rather than investigating the effects on achievement, courseware designers were more interested in the effects of courseware on higher order thinking skills.

Studies of the effects of CBI on thinking skills of elementary students included one by Riding and Powell (1985). In the study of 36 four year old childrens' critical thinking skills, it was found that the group of children who received 16 computer-presented problem solving activities showed a significantly greater gain on their Raven's Colored Progression matrices posttest scores than did the control group. Similarly, Jussel (1990) found in a pilot study that computers could be successfully used to help fifth and sixth grade students to enhance or develop their problem solving skills.

In another study, Bass and Perkins (1984) examined verbal and inductive/ deductive reasoning of seventh graders. They reported a positive impact of computer-assisted instruction as measured by standardized tests. Similarly, Pogrow (1985) studied the higher order thinking skills of fourth, fifth and sixth graders. He compared the learners' thinking ability in two subjects viz. reading and mathematics. The study found that the thinking ability of learners who used computers was better than those who did not use computers. Subsequent studies by Pogrow (1987) found that the higher order thinking skills program had been effective in helping students develop metacognitive, inferencing and decontextualization skills coupled with the ability to combine and synthesize information.

Studies were also conducted on the effects of CBI on secondary grade students. Denning's (1994) doctoral study carried out in the United States, based on a design to develop secondary students' diagnostic reasoning in Biology, interacting in a computer-based learning environment found a 44% improvement in students' abilities to generate a set of hypotheses. In another study carried out in Australia, Maor (1991) found a statistically significant increase in the mean scores for a total sample of 122 students in inquiry skills of interpreting, analyzing and application. The study was carried out to investigate the extent to which students' inquiry skills can be facilitated through the use of a computerized science database and specially designed curriculum materials for grades eleven and twelve.

In a similar study, Myers (1993), from the United States developed a learning environment that included a hypermedia database about Mesoamerica. It was an observational study of middle school students using the system within a framework of problem-based learning for mastering content and thinking skills. The study reported that embedded problem-solving strategies facilitated higher order thinking only when coupled with teacher support. In another study, evaluating a model technology program intended to develop critical thinking abilities of junior high school students, Jacks' (1996) doctoral study reported an improvement of critical thinking skills over a 3-year period. To evaluate the study, qualitative data in the form of survey questionnaires, in-depth interviews, observations and examination of documents and reports were conducted. This was supported by quantitative data collected from two tests of critical thinking, that is the Cornell Critical Thinking Test, Level X (Ennis and Millman, 1985) and the Ennis-Weir Critical Thinking Essay Test (Ennis and Weir, 1985).

At the college level, Knezek (1995) carried out a doctoral study to determine the relationship between computer intensive class work and change in critical thinking skills of freshman college students for a writing program. A pre/post test analysis was carried out to determine the results using the Watson-Glaser Critical Thinking Appraisal for inferences, assumptions, deductions, interpretations, arguments and total scores. The findings recorded a significant difference for assumptions and inferences. In total change score, the computer group did better than the non-computer group. Other studies include those by Stamper's (1996) and Andrusyszyn's (1997) doctoral studies on adult students' facilitation of reflection in a computer-mediated environment. The two studies show that higher order thinking tasks such as reflection and critical thinking can be actively fostered through these activities.

The above studies conducted between 1972 and 1997 to find out the effects of CBI on higher order thinking shows that CBI did have some effects on the thinking skills of students at the elementary, secondary and college levels. However, it must be noted that the research literature does not always present positive effects of the use of the computer in enhancing the higher order thinking skills of K-12 students.

Orabuchi (1992) in a 4-month experimental study found that computer-assisted instruction with varieties of interactive software was not effective in teaching higher order thinking skills of sixty-one first graders and seventy second graders. Fox (1990), carried out a study to investigate if an environmental simulation would improve 74 eighth and ninth grade students' critical thinking abilities of identifying and assessing factual and value claims and to develop and present arguments. Methodologies to test the participants' change in critical thinking skills were a single subject (multiple probe) design, discourse analysis and evaluative data from teachers. It was found that the single subject analysis did not support the improvement of critical thinking skills.

In a more current study, Mitchell (1996), carried out a doctoral research in the United States to determine the effects of a technology-rich environment on higher order thinking skills of grade four and grade six students. The activities involved writing, creating graphics, researching, controlling robots and telecommunications. The study found that there was no significant effect between the experimental, control and placebo groups for either fourth or sixth grade students. However, within the experimental group of low, average and high ability students, there was a significant difference for the sixth grade group.

Another study using simulations was carried out by Geban, Askar and Ozkan (1992) in Turkey to determine if using computer-simulated experiment did improve grade nine students' achievement on chemistry and science process skills. A total of 200 students were involved in the study whereby 60 were in the computer-simulated treatment, 70 students in problem-solving treatment and 70 students in the conventional treatment. There was no significant difference in the science process skills when the problem-solving group was compared to the computer-simulated group.

The above studies reviewed used a combination of computer-based techniques such as interactive multimedia, databases and simulations in a closed system revealed that the effect of computer-based learning on the higher order thinking skills of students were inconclusive.

Recently, computers have been used in a more open learning type of networked-based environment. These learning environments adopted instructional techniques based on a constructivist conceptual framework and the following are examples of studies using the approach.

Polman's (1997) doctoral case study explored the complexity of project-based science in a high school where students design earth-science projects using the Learning Through Collaborative Visualization (CoVis) principles of open-ended inquiry incorporating Internet tools. The researcher explored design issues involved in such an endeavor. Some of the issues reported were time constraints on both teacher and students, how traditional school culture and grading create stumbling blocks for change, and how conflicting beliefs about teaching and learning undermine the accomplishment of guided inquiry. In particular, the study showed how Internet tools such as Usenet, e-mail, and WWW afford students an opportunity to gather and make use of distributed expertise and scientific data resources. Similarly, in another doctoral study, Stuve (1997) used theories of collaborative learning and project based teaching to carry out a three-year descriptive study in a dual-level third and fourth grade classroom. The activities carried out through a team-teaching methodology revolved around networked computers. The research methodology used included classroom observations, interviews, electronic discourse and student-generated artifacts. The findings reported that activities surrounding technological innovations are socially constructed. The study also reported on the efficiency and accessibility of technology in an elementary classroom.

Lebow (1995) conducted a doctoral study using a case study method to investigate how graduate students function in a constructivist computer-supported learning environment. A graduate level course was developed to aid among others student reflection and higher order thinking skills. Five themes that have relevance for the design of constructivist learning environment emerged from the results of the study mainly related to the teaching-learning process. They included discomfort and overload, self-direction and teacher guidance, personal construction and enculturation, divergence of opinion and shared meaning, and authenticity and contrivance.

In a related study, Vullo's (1993) doctoral study explored the educational promise held by the new computing technology of hypermedia. Constructivist learning theories were used to devise simulations and hypermedia based activities to test if students learn by using these technologies and how students use these technologies. The study found that students showed measurable learning from the system.

Similarly, other research projects were carried out to record the processes involved in a technology-based learning environment. The Apple Classrooms of Tomorrow (ACOT) was initiated in 1985, in which several studies were conducted to determine how the routine use of technology by teachers and students might change teaching and learning. In the ACOT classrooms, technology was used as a tool for learning and a medium for thinking, collaborating and communicating. The research showed that the use of technology did significantly increase the learning, especially when used to enhance higher order thinking, collaborative processes and information access. A total of 22 research reports, and a series of effectiveness reports were published. In relation to this, Tierney et al. (1997, ACOT Report #16) from the Ohio State University carried out a four year longitudinal study on the influence of computer access on six high school students. Data collection techniques included detailed observations and lengthy interviews. The study identified eight competencies that were acquired during the four years namely: active exploration and representation of knowledge, effective communication, better computer use, student independence, expertness and collaboration and a positive orientation to the future.

In conclusion, it can be said that while the findings with regard to the efficacy of computer technology in enhancing learning and thinking remain unclear, the studies have identified some of the processes involved in a technology-rich classroom. Also there appears to be a shift in the direction of research from computer-assisted-instruction to multimedia and web-based learning environments. In the web-based learning environments, qualitative data provided insights into teaching-learning processes, classroom management procedures and curriculum design techniques. The present study seeks to explore further the processes involved in a technology rich classroom and its effects in enhancing higher order thinking skills of primary school students in Malaysia.

Cooperative and Collaborative Learning

While laboratory research on cooperation can be traced back to the 1920s, research on specific cooperative learning methods dates back only to 1970 (Slavin, 1982). Cooperative learning refers to instructional methods which students at all levels of performance work together in small groups toward a common goal (Slavin, 1982). Johnson and Johnson (1983) argued that cooperative learning promotes the use of higher reasoning strategies and greater thinking competencies (Johnson & Johnson, 1983).

Early cooperative research efforts concentrated on the effectiveness of using different cooperative learning methods and the effectiveness of cooperative learning as compared to individual learning (Johnson et al., 1981; Slavin, 1987; & Blaye, 1990). Research was also carried out to ascertain if cooperative learning was more suitable for certain ability groups (Kuhn, 1972; Azmitia, 1988). With the introduction of computers into the classrooms, research concentrated on CAI and its effects on cooperative and individual learning (Mevarech, Stern and Livita, 1987; Dalton, Hannafin & Hooper, 1991). Research also looked at CAI and cooperative learning viz ability levels (Simsek & Hooper, 1992; Hooper & Hannafin 1991). Later research was carried out to determine closed networked learning systems such as ILS and its effects on cooperative learning as compared to individual learning (Brush, 1996). There were few research efforts that looked at cooperative processes (Miyake, 1986 and Kempa & Ayob, 1991).

Collaborative learning is learning whereby support is provided by an individual or group of people to another individual or group to achieve their learning goals. While cooperation was a very popular technique of instruction, collaborative efforts were hampered due to a lack of classroom supportive structure. But with the introduction of open networked systems, collaboration became an important buzzword. Research on collaboration became more rigorous with the emergence of open learning systems such as the Internet, which became a popular medium of communication. Collaborative research efforts conducted included those researching on the efficacy of open networked systems and the practice of science (Pea, 1993); distance education,computer conferencing & critical thinking (Fabro, 1996; and Shell et al., 1995).

With respect to cooperation, Johnson, Maruyama, Johnson, Nelson, and Skon (1981) reviewed 122 studies comparing the effects of cooperative learning versus individual learning conducted between 1924 and 1981. Results indicated that cooperative learning experiences tend to promote higher achievement than competitive and individual learning experiences. These results hold for all age levels, all subject areas and different tasks such as concept attainment and problem solving. Subsequently, an examination of 226 studies comparing cooperative with individual learning showed that cooperative learning was more beneficial than individual learning (Johnson and Johnson, 1989).

Similarly, Slavin (1983b) examined 46 studies in which cooperative learning groups were compared with individual instruction. Of those 46 studies, he found that 29 reported a significant increase in achievement levels for students participating in cooperative learning groups with another 15 showing no significant differences. Slavin further noted that the studies which did not show learning gains for students in cooperative learning groups did not incorporate one or more of the important components of cooperative learning. In a second meta-analysis Slavin (1987) analyzed studies which compared the effects of cooperative learning on achievement with those of students in individual learning situations. Of the 38 studies reviewed, Slavin found that 33 reported significant increases in academic achievement for students participating in cooperative learning situations. Blaye , Light, Junior and Sheldon (1990) also showed that children who had previously worked as cooperative partners on planning and problem solving were twice as successful as children who worked alone.

However, with the introduction of computers in the school, research on cooperative and collaborative learning was conducted to ascertain the effects of computer-assisted instruction (CAI), computer-based instruction (CBI) and integrated learning systems (ILS) on cooperative and collaborative learning. Some logistical problems of using computers such as overcoming computer hardware shortages and the fact that using computers may promote social isolation which was inherent in the design of most CBI programs led many researchers to incorporate cooperative and collaborative learning methodologies in computer-assisted classrooms. Apparently, students have much to gain from cooperating while working at the computer. Johnson and Johnson (1985) noted that students could: observe and imitate each other's use of the computer; observe, imitate and build upon each other's strategies thereby increasing mastery; experience the encouragement, support, warmth and approval of classmates; have peers evaluate, diagnose, correct and give feedback on understanding; have greater exposure to diverse ideas and procedures; and develop more critical thinking and more creative responses.

Early studies concentrated on the effects of using computers in cooperative learning situations as compared to individual learning situations. With respect to this, Mevarech, Stern, and Levita (1987) conducted a study to compare the effectiveness of language arts CAI lessons on junior high school students working in cooperative groups and individually. Results showed that students who worked cooperatively on CAI lessons demonstrated significantly greater academic gains than their peers who worked individually on the CAI lessons. Similarly, Dalton, Hannafin and Hooper (1991) carried out a study on the effects of individual and cooperative computer-assisted instruction on student performance and attitudes. A total of 60 eighth-graders received treatments that either required individual work or encouraged cooperation with a partner. Results indicated that students who worked cooperatively significantly outperformed those who worked individually.

With the advent of networked computers and servers, CAI evolved into powerful and integrated learning systems (ILS). An ILS is generally implemented in a computer lab of 15 to 30 computers linked to a central file server (Brush, 1996). The file server contains lessons, which can be accessed by the students. It also maintains detailed records of each student's progress and performance, which the teacher can access at any time for assessment and evaluation purposes. The research dealing with the academic effectiveness of combining cooperative learning with ILS delivered instruction is somewhat limited.

A study carried out by Mevarech (1994) investigting the impact of using a cooperative versus individual mode when using an ILS system developed in Israel indicated that students working in cooperative groups performed significantly better both for mathematics basic skills and higher-level concepts than their peers who worked individually.

In a related study, Brush (1996), examined achievement and behavior differences between 65 elementary school students completing ILS activities in a traditional, individualized format and students completing the same activities in cooperative learning groups. This was in order to determine if a cooperative learning model could be used effectively with students completing mathematics activities in a lab-based ILS. In addition, this study aimed to discern if the cooperative strategy was more effective for students with high or low academic ability levels. Achievement and attitudinal data were collected for all fifth grade students in the selected school prior to the experiment and at the end of the treatment period. Results revealed that students using an ILS for mathematics instruction performed better on standardized tests and that attitudes were more positive when they completed the computer activities in cooperative groups.

Another study comparing individual learning with cooperative learning was carried out by Klien & Doran (1999). The study investigated the effects of implementing individual and small group learning structures with a computer simulation in accounting. A total of 105 college students participated in the study whereby they were randomly assigned to either the extensive small group structure (n = 36); occasional small group structure (n = 36) or individual small group structure (n = 33). Results indicated that performance scores were high regardless of learning structure. However, students who worked alone expressed significantly more continuing motivation for their learning structure than students who worked with a partner.

At this point it can be concluded that cooperative learning strategies showed improvement in student achievement scores and attitudes when compared to individual learning strategies in a non-computer supported classroom, as well as in classrooms equipped with computers.

Research has also examined the effectiveness of cooperative learning with students of different academic ability levels. It is important that for cooperative learning to be effective, cooperating peers be paired appropriately. In this respect, a study by Kuhn (1972) found that homogeneous grouping according to ability level between cooperating peers was more conducive to cognitive growth than heterogeneous grouping.

However, Azmitia (1988) found that novices in paired heterogeneous groups improved significantly as compared to homogeneous ability pairs. Similarly, Laughlin and Branch (1972) (in Webb, 1993) conducted one of the most comprehensive studies to compare different group compositions according to ability level. A total of 1008 college students were divided to four-person groups, which resulted in fifteen homogeneous and heterogeneous groups. Students were given the Terman Concept Mastery Test individually, and later they took the test again in groups of four. The results showed that group performance was determined by the level of the highest member of the group and the number of individuals at that ability level. The results also showed that individuals benefited from working in groups with persons of higher ability but not in groups with persons of lower ability. In a qualitative study by King (1993), third grade students received mathematics instruction in cooperative groups consisting of two students classified as being high achieving and two students as low achieving. Observations revealed that low-achieving students make minimal contributions to the group while high ability completed most of the work without input from the other members of the group.

The above studies reveal that in a non computer-based classroom, lower ability students either benefit or do not contribute to group activities when grouped heterogeneously. In a computer supported classroom, Hooper and Hannafin (1988) grouped eighth grade students into low and high heterogeneous and homogeneous groups working cooperatively during CBI. Students received identical instructions during CBI on mathematics. There were no significant differences in achievement between the two grouping methods. However, the low ability students' achievement in the heterogeneous groups improved substantially. The results also show that there is little to risk in terms of achievement but much to gain in terms of socialization and interaction by cooperative heterogeneous grouping during CBI. Similarly, Yueh and Alessi (1988) grouped students into all medium ability and mixed-ability and found that ability level had no significant effect.

Hooper & Hannafin (1991) also investigated the effects of cooperative group composition, student ability and learning accountability on achievement interaction and instructional efficiency during computer-based instruction. A total of 125 sixth and seventh grade students from a rural predominantly white middle school were randomly assigned to heterogeneous or homogeneous dyads. Indicators of on-going cooperation were collected during instruction. Five days later students completed a posttest. It was found that low ability students interacted more and completed the instruction more efficiently in heterogeneous than homogeneous groups. High ability students completed the instruction more efficiently in homogeneous rather than heterogeneous groups. Cooperation was significantly related to achievement for heterogeneous ability groups, but not for either homogeneous high- or low-ability students.

In a study by Simsek and Hooper (1992), 30 fifth and sixth grade students worked either independently or cooperatively on a videodisc lesson on whales. The mixed ability cooperative group consisted of one low ability student and two high ability students or two low ability students and one high ability student. Posttest results revealed those students participating in cooperative groups, regardless of ability levels, scored significantly higher.

A study conducted by Temiyakarn and Hooper (1993), on the effects of CBI on paired high and low achievers found that both the high and low achievers increased achievement. The study also determined whether low achievers learned as effectively in learner controlled conditions as compared to program controlled conditions. This is because previous research indicates that low achievers did poorer using learner controlled than using program controlled CBI learning (Carrier & Jonassen, 1988). This study showed no difference between program control and learner control for low achievers.

Results have been inconclusive as to whether homogeneous or heterogeneous groupings are better in either traditional or technology supported classrooms. When learners' achievement was compared to homogeneous and heterogeneous grouping to ascertain which was a better grouping method, it has not been well established whether homogeneous or heterogeneous groupings are more effective for learning. However, research in the strategy has been thus far limited to the results and effects of cooperative learning on achievement and not to an examination of the processes involved in cooperative learning.

The following section describes studies carried out on cooperative learning processes. According to Johnson et al. (1984), the basic elements of cooperative processes are positive goal interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group self-evaluation. For cooperative learning groups to be successful, students must be engaged in the needed cooperative processes. In a review of studies on cooperative learning, Slavin (1990) identified positive interdependence and individual accountability as the two most important features of effective cooperation. Slavin cites four reviews which concluded on the same note, namely Slavin (1983, 1989); Johnson et al.

(1981); Newmann and Thompson (1987) and Davidson (1985). Deutsch, (1962) and Johnson & Johnson (1975) explains that positive interdependence occurs when students perceive that they can reach their learning goals by working together. This can happen when they discuss the material with each other, help one another understand it, share their workload, and encourage each other to work hard. Individual accountability means that the learner is accountable for his or her learning and steps are taken to verify this.

An experiment by Miyake (1986) confirms that in the learning process, the bulk of constructive criticisms occur while learning in cooperation. The experiment showed that about 80% of self-critiquing (reflection) took place during cooperative learning compared to 20% when students were learning alone. Kempa and Ayob (1991), explored the effectiveness of small-group learning in science, whereby the verbal interactions among pupils engaged in problem-solving tasks were studied. Analysis of group interaction showed that interactions were predominantly task-related. The discussion of content was mainly at the factual level and discussion of content at higher cognitive levels was largely absent. Interaction patterns within groups found that mostly, two pupils were involved in a dialogue at any one time. Other research reviews mentioned by Kempa and Ayob include by Boydell (1975) and Galton et al. (1980) which reports that group talk was not task-related and conversations were not sustained.

Sherman and Klien (1995), found that in cooperative learning, the amount and type of verbal interactions determine the achievement and attitude of students. After reviewing several small group studies, Webb (1989) reported that students in small groups who give or receive explanations during a lesson learn more from the lesson than those who don't exhibit these interaction behaviors. Furthermore, King

(1989) found that small groups that were actively involved in discussions about the activities related to the task, discussed and elaborated solutions were more successful at problem solving than groups that did not exhibit these interaction behaviors (in Klien & Doran, 1999, p. 98). In a study comparing the type and amount of social interaction during regular classroom activities to that around computers, results indicated that more task-related interaction occurred among children working with computers than among those doing tasks not related to computers (Hawkins et al., 1982).

Johnson, Johnson, Stanne and Garibaldi (1990) conducted a study to determine if group self-evaluation was a variable in determining achievement in cooperative learning. The sample included forty-eight high ability Black American high-school seniors. Group self-evaluation is defined as a review of a group session in a reflective manner to determine which actions taken were helpful and unhelpful and decide which to continue or change. Four conditions were included in the study: cooperative learning with no self-evaluation, cooperative learning with teacher led self-evaluation (the teacher specified what cooperative skills to use, observed, and gave whole-class feedback about how well students were using the skills), cooperative learning with teacher and student led self-evaluation (after teacher feedback, students discuss how well they interacted as a group), and individual learning. The students participated in a 3-hour instructional unit that paired a computer simulation with written materials for 4 weeks. Students worked in groups of three. It was concluded that students in the three cooperative conditions performed better than those in the individual condition. The combination of teacher and student-led self-evaluation resulted in greater problem solving success and achievement in the cooperative conditions.

In another study, Yager, Johnson, Johnson and Snider (1986) examined the impact on group productivity and individual achievement of cooperative groups with self-evaluation, without self-evaluation and individual efforts. They found for elementary school children, cooperation with group self-evaluation promoted the highest level of achievement and individual efforts resulted in the lowest level.

In the two studies conducted on group processing (Yager et al., 1983 and Johnson et al., 1990) it was not determined if the group self-evaluation results were better for homogeneous or heterogeneous groups; if there was a relationship between the student responses and achievement for content and higher order thinking.

While little is known about the relationship between interactions and learning in cooperative groups, many researchers agree that cooperation and achievement are positively related. The present study will examine cooperative processes as related to ability levels and attempt to determine the preferred way of grouping students for cooperative and collaborative learning in a web-based constructivist learning environment.

Teacher Role in a Technology-Based Classroom

In traditional classrooms, the teacher is seen as a transmitter of information. The teacher sets the learning objectives, and ensures that the learners achieve as much of the objectives towards the end of the teaching period. However, prompted by massive revolutions in knowledge, information technology, and public demand for better learning, schools are slowly restructuring themselves. They understand that the essence of education is a close relationship between a knowledgeable, caring adult and a secure, motivated child. They grasp that their most important role is to get to know each student as an individual in order to comprehend their unique needs, learning style, social and cultural background, interests and abilities. Thus, in student-centered inquiry classrooms, teachers motivate children to explore and 'facilitate' or 'scaffold' their understandings of the world. In this type of learning environment, the teacher provides children with the knowledge, resources and activities that help them create and develop ideas. The following section describes some studies related to how teachers are using the Internet in the classroom in a more integrated way.

Fowler (1992) conducted a study on teachers who were actively using Computer Managed Communication (CMC) in their classrooms. A total of 25 respondents were interviewed following a script consisting primarily of open-ended questions. The interview began with an open-ended request where teachers were asked to describe the things they do with their students using telecommunications, their achievement and problems. With regards to the types of CMC used in the classroom, 4 major types were identified: structured projects, activity connections, online services and generic connections. Structured projects typically provide curriculum guides that specify in considerable detail the classroom activities and kinds of telecommunications adopted. Examples of such providers include National Geographic KidsNetwork, LabNet, Star Schools Project, GlobalLab, and AT&T Learning Network (Fowler, 1992). Activity connections provide access to online curricular-based projects. Some are provided by the system organizers whilst others are offered by the teachers who connect. Examples are Iris and FrEdmail. Online services include America Online and Prodigy. They provide e-mail, encyclopedia services, educational programs, access to databases, news and live conferencing. Most of the teachers had used the generic systems. These included the Internet, BITnet and BBS. Most teachers agreed that it is easier to participate in the structured programs.

One of the most consistent themes emanating from the interviews was the impact of telecommunications activity on the social organization of the classroom. It was indicated that the use of CMC changed the way the classroom functioned. In many cases, patterns of cooperative learning developed. All the teachers reported using group activities with CMC. Collaboration improved the effectiveness of learning by imposing peer evaluations on students' products from around the world - not just a teacher's reaction to their work. The findings support other studies conducted by Cohen & Reil (1989), Riel & Levin (1990), and Weir (1992). Writing for real audience was one of the factors that prompted a number of the teachers to use CMC as these provided a meaningful context for the students.

Coverdale (1996) carried out a doctoral study whereby a fourth grade teacher who utilized instructional technology in varied ways to advance her students' scientific literacy was observed for five months. The study provided insights into current conceptions of scientific literacy, described what a technology-rich curriculum might look like and documented the teacher's integration of instructional technology across science curriculum. The study also described how fourth grade students utilized instructional technology in pursuing scientific inquiry. It was reported that frequent use of the Internet to access and share information allowed the students to extend their learning into real world context.

Similarly, Wyld (1996), conducted a study to identify how primary schools are presently using the Internet and the World Wide Web in their classrooms, how CMC is integrated into teaching and learning and what factors influenced the success and difficulties of integrating this technology into primary education. Five schools in the Sydney area which had been using the Internet for 6-12 months were selected for the study. It was found that the Internet was being used in four main ways, namely to initiate e-mail communication, search for resources, establish home pages and participate in global projects.

Alagbe's (1997) doctoral study investigated patterns of use, effect on roles and relationships, problems and preparation needs posed by Internet use in four classrooms. The study was guided by the constructivist learning theory and teacher decision-making theory. Data sources were teachers, students, lesson plans, and student work. Data were collected through observations and interviews. Patterns of use of the Internet among students included using the Internet to search and access information, communicating via email with collaborative partners and creating web pages. Teachers used technology to download lesson plans and identify relevant sites for students. Major decisions that teachers faced include classroom management with regard to equitable time for all students; structuring multidimensional projects such that students were engaged in a task even when not directly interacting with computer; productive use of cooperative grouping strategies; and authentic assessment. Also it was found that modeling as an instructional strategy was successful and groupings based on students' interest were more successful than those based on students' skills level.

On the other hand, Cooperman (1998) conducted a study focused on the role of the teacher whereby the purpose was to find out the interaction between teachers' pedagogical beliefs and their early use of the Internet in the classroom. Three teachers teaching grades 5-8 participated in the research for six months. Data sources included observation of teachers in action, multiple interviews with participants and colleagues written personal histories and classroom artifacts. Differences in teachers' early Internet practices stemmed from pre-existing pedagogical beliefs particularly those related to how students learn. The evidence also revealed four beliefs common to all participants: a) the teachers' personal practical knowledge is the basis for classroom operation; b) technology is a valuable and primary asset; c) good teachers are innovators; and d) teachers are instructional designers. It was also found that beliefs were not the only determinants of Internet use in the classroom. Teaching experiences, collegial support, and school culture influenced initial choices.

Nicaise and Crane (1999) carried out a study on a graduate course to discern how a "student-as-multimedia-author approach" translated into classroom practice for graduate students. One goal of the study included keeping track of instructor activities. Accordingly, the instructor maintained a log of each 3-hour class period. While students worked, the course instructor visited individuals or pairs to check progress, pose questions, offer resources, teach skills or critique student work. Overall, 17% of the time was spent in activities where the instructor provided information to students via large group and direct lecture. Also 6% of the time was spent in providing information to students via large group and direct lecture on how to use certain technologies. About 12% of the time was spent helping students to collect information that was specific to each student's chapter topic. The instructor spent 19% of the time in teacher-student conferences where she helped individuals or pairs develop ideas. This included reading drafts of papers, asking students to clarify ideas and asking students to identify media to support their conclusions. Another 33% of the time was spent in teacher-student conferences helping individuals or small groups develop technological skills.

One difficulty was providing students with equal access to the instructor's time. While the instructor worked with an individual, others needed to wait for attention; on occasion, some waited for an hour. Three individuals had extreme difficulty with the concept of self-directed and self-regulated learning; these individuals required much more support from the teacher. The research concluded that future researchers need to thoughtfully examine and identify support systems that will help teachers to create, manage, and sustain a student-as-multimedia-designer approach.

Wiesenmayer and Koul (1998) conducted a study on teacher's perceptions on the impact of RuralNet on their teaching practices. Semi-structured interviews and two identical online surveys were used to collect data from teacher participants. A total of 168 teachers were involved in the survey on teachers' perceptions of changes in teaching practices. Ten teachers were interviewed with a purpose to uncover their meanings, perspectives and understandings regarding the Internet resources and use for collaboration, research and investigative activities. Findings showed classrooms have become less teacher centered and more investigative. With regards to the Internet as a curriculum resource, a large number (79%) reported that they supplemented textbook material with material from the Internet. In conclusion, there is a general enthusiasm on the Internet usage and perceived changes in teaching practices.

In another study, Thompson (1999), examined and described the current state of availability and use of the Internet among high school Vocational Education teachers in Idaho and evaluated the concerns these teachers have about using the Internet in teaching, and recommended intervention strategies that could be used to facilitate the development of higher level concerns. A total of 438 teachers were given the survey forms with a 72.8% return rate. It was found that 94% of the schools had some form of Internet access. Most teachers were self-taught in

Internet use. E-mail was the most common form of Internet service used. A total of 40% of the teachers used the Internet sometimes for lesson planning, classroom instruction and personal development. The more training teachers had, the more interested they were in how to use the Internet and understand how it affected their students. It was also found that the more often teachers use the Internet in conjunction with lesson planning, classroom instruction and personal development the more concerned they become about the impact it will have on their students. They were also concerned about working with their colleagues and others in co-ordinating the use of the Internet and ways to develop and obtain new ideas to improve their use of the Internet.

Kayany (1999) carried out a study to identify the perceptions and observations of instructors on how web pages have been used by their students and how such use had affected classroom processes. An exploratory study was employed using open-ended questions. A total of seventy-eight instructors from various disciplines, whose web-sites were available at the World Lecture Hall website were involved in the study. The findings showed that the availability of course materials on the web had the potential to increase students' level of class preparation, participation and attention and above all increase interaction between instructors.

Thus, there are many different ways teachers have incorporated computer-managed communication (CMC) in the classroom, but the structured programs were most favored. It was found that the use of CMC led to the use of cooperative and collaborative learning strategies. In a CMC environment, the role of the teacher was to create activities where there was a 'real audience' to view student work. Studies show that frequent use of CMC extended students learning into the real world context. In a computer-managed classroom, teachers were faced with decisions related to classroom management, structuring multi-dimensional activities and ensuring cooperative groups were productive. Lastly, it was revealed that for a teacher to be successful in a computer-managed classroom, apart from institutional support, teacher skills and believes were important.

Conclusion

Generally, studies showed that students who learned with the aid of a computer had better achievement scores, learned in less time and were more positive towards learning as compared to students who learned in a non-computer environment. However, studies on the effects of computers on higher order thinking were inconclusive. Later studies on the effects of computers were more qualitative in nature, exploring teaching-learning processes in a more networked and open-type of classroom environment. Similarly, many studies were conducted comparing the effects of computers on cooperative learning versus individual learning. These studies showed that cooperative partners performed better than individuals in achievement tests. However, studies carried out on the preferred ability groupings were inconclusive, i.e. if it was better to group students homogeneously or heterogeneously. There were fewer studies on the types and quality of cooperative and collaborative processes in a computer-based environment especially where students are able to connect to other students and experts. In determining the role of the teacher in an open-learning web-based type of environment, studies carried out tended to be more focussed on the types of services that teacher preferred to use and teacher attitudes towards Internet and web-based learning. Although some studies did highlight the change in teacher role, classroom management and management of cooperative groups, there is insufficient evidence on the specific role of the teacher as a facilitator.

As a result of the analysis, it was imperative to carry out a study with regards to the impact of a web-based learning environment on learners achievement and thinking skills, the nature of cooperative learning groups and collaborative learning processes. Also it was deemed important to study in detail the role of the teacher as a facilitator so that a more comprehensive classroom pedagogy could be proposed.