CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Introduction

As we move into the information age, Information and Communications Technologies (ICTs) makes its appearance in all aspects of our lives. We need to acquire new skills to manage all the information. To accomplish our daily tasks we need to extract knowledge from the vast information capacity of ICTs and tailor them to our needs. This shifts our role as information seekers to information managers. Our schools should also make a paradigm shift from being information providers to providers of skills to manage information. This means our students need to be taught how to analyze, apply, synthesize and evaluate information which are the higher order thinking skills mentioned in Benjamin Bloom's taxonomy of cognitive skills (Paul, 1985).

Benjamin Bloom's taxonomy of cognitive skills explains the developing and delivering of teaching activities that promote these skills. Teachers are encouraged to ask questions and construct learning activities that go beyond simple facts and lower level understanding. They are to construct questions and activities that require higher order thinking skills.

2.2 Why ICTs are considered a powerful teaching and learning tool in promoting higher order thinking skills

Byron (1997) explains why ICTs can be a powerful tool in enhancing the teaching and learning experience. Some of the following ways have been cited:

As a support mode: Use of word processors to develop writing skills and use of electronic mail to communicate presentation of texts for a potentially large readership have prompted the motivation in students which is intrinsic and meaningful.

- For simulations: With simulations students can experiment with virtual situations which may be impossible to represent in real life within the school environment.
- For creating and designing: ICTs enables the creation of new designs and production through combining various media in one product.
- As an information resource: ICTs allows students to develop questioning and research skills.
- Provides a link: Its ability to link with other individuals and communities exposes students to new socio-cultural and cross-cultural perspectives on diverse issues.

Possessing all these capabilities mentioned by Byron (1997), teachers can capitalize on ICT usage to teach higher order thinking skills by various methods.

2.3. Methods that can promote higher order thinking skills using ICTs

The teaching methods using ICTs that can promote higher order thinking skills are mostly dependent on how creatively teachers structure their lessons. The following methods has been successfully used by innovative teachers.

2.3.1 Using ICTs in Inquiry Learning

McDaniel (1994, p.74) states, "It is our thesis that computers will play their most significant role in shaping the classroom of tomorrow when they are used in the context of student inquiry". He further discusses an inquiry sequence in a history class growing

out of the battle of Shiloh during the American Civil War. In this exercise students listen to an audiotape that contains three disparate accounts from actual eyewitnesses of the battle and from that try to determine what happened at Shiloh. They also learn to evaluate statements of the witnesses, the motivation and probable bias of the reporter. Students can also examine folders containing additional information like what other soldiers saw, medicine and surgery, deaths from diseases, bridging equipment, landmines, horses, music and art, food and economic and social changes associated with the civil war. Here students not only learn the modes of inquiry into history but can make their own conclusions about events. This is possible because many teachers can transfer materials, which are organized and maintained as tape recordings and file folders, to laser disk for easy use.

According to Wallace, Krajcik & Soloway (1996), inquiry learning can be supported by digital libraries. Inquiry learning enhances the understanding in the study of Science. In inquiry based learning students need to be able to ask meaningful questions which are non-trivial content and which are capable of driving their investigations. Also they need to seek information about their questions and collaborate with other students as they make meaning of the results of their investigations. They need to create projects, reports, or other artifacts through which they can share what they have learned. Further, they need to have access to sound technological tools, which support their meaning making.
The digital libraries like the University of Michigan Digital Library (UMDL) offer the possibility for teachers and students to have access to extensive materials and data across a wide range of subjects from within the classroom or school library.

McKenzie(1994) emphasizes that the most dramatic benefits from new technologies like telecommunications emerge when teachers organize their classrooms around student learning rather than teaching. The teacher orchestrates investigations and projects, helping students to construct meaning and develop insight rather than ladling it out with silver spoons. In constructivist classrooms, teachers accept and encourage student autonomy and initiative, use raw data and primary sources, encourage student inquiry and nurture their natural curiosity. He further argued that if teachers come to see technologies and student centered classrooms as offering something magical, then they would be inspired to model the kinds of learning we hope to see as we move into the next century.

He also stresses that personalizing the learning experience of students by making available information rich network alone is inadequate. Students should be presented with essential questions to focus on. For example, in a workshop on Power Learning, the participants were asked the essential question. "Your team is a world renown consulting firm hired to advise the Minister of Health of an African nation on the most powerful ways to reduce the infant mortality rates of the nation. You will explore a vast database drawn from World Bank data and test the power of relationships between infant mortality and variables such as rates of inoculation to see which variables deserve the greatest attention."

The teams brainstormed variables, posed hypotheses, explored the electronic encyclopedia and then went searching into the immense database, cutting and pasting data into a spreadsheet and beginning the generation of graphs. They were all puzzled by the quest for meaning, challenged by the question and motivated by the making of meaning.

2.3.2 Using ICTs for Projects

Teachers can make students work independently or in groups investigating a problem of some sort, chosen by the student or group in consultation with the teacher. This method allows students to exercise initiative to see not only the practical application of a subject but also to cross subject area barriers, to probe deeply into a particular area of study and to become responsible for organizing and structuring their activities.

An example given by Dwyer(1994, p.7) in the Apple Classroom of Tomorrow (ACOT), a program which routinely engages students systematically in high order cognitive tasks where students in the 9th and 12th grade work on interdisciplinary projects. In one of their projects they created a scale model of the renovated business district of Columbus. They spent a month researching buildings, interviewing occupants and architects, measuring and scaling skyscrapers to size. As a final product, the students created a 20 by 20 feet scale model including robotic elements they had built and programmed, controlled by a dozen computers.

Another example by Levin, Riel, Myiyake and Cohen(1987) cited in McDaniel (1994, p.75) reported a "water project" in which students, teachers, professors and undergraduates from the US, Mexico, Japan and Israel shared information about water problems in their towns. Through the Internet, students analyzed information from other sites and wrote reports on methods that could improve local water management.

Means and Olson (1994) discussed a case study by the Office of Educational Research and Improvement where students in a 5th grade class were involved in a long term project employing computer technology. It was a multimedia project to develop curriculum on local minority leaders, which they named as "Local Heroes Project". It

involved identifying local Hispanic, African American and Vietnamese leaders, conducting and videotaping interviews and composing written highlights from the interviews. This project was a complex task which called for high level thinking. For example, they had to analyze interviews with famous people in order to develop a set of questions that would elicit certain information and generate interesting responses. By doing these, students learnt concepts of open-ended and close-ended questions as well as presentation techniques. After completing the fieldwork, students reviewed and critiqued its videotaped interviews before entering text on to the computer for later editing and formatting.

2.3.3 Using ICTs in Problem Solving

Access to ICTs, especially its interactive nature, enhances the problem solving and reasoning skills of the learner. By teaching problem solving, students learn how to organize complex information, recognize patterns, draw inferences and exhibit superior organizational skills all of which requires higher order thinking skills.

Riley(1996) explains how several mathematics software programs are used by students to solve problems that are simulations of real life problems. Each segment in the series presents mysteries or problems encountered by the main character that require mathematical solutions. In one, students must figure out if the main character has enough gas and time to get his boat home without refueling. The data necessary to solve the problems are embedded throughout the stories, requiring students to first determine which information is relevant to the solution and use their skills to solve the problems at hand.

Another program uses a story about a planet with a disappearing rainforest. Students manipulate geometric shapes to repair damaged bridges, learn map reading skills to navigate rivers and roads, develop logic skills as they program robots to help them and use algebra to pack parcels they find along the way.

Dwyer, (1994) describes how ACOT middle school students work with IMAGE; a professional scientific visualization tool developed by the US National Institute of Health. They also solve problems using planetary images downloaded from satellite visual data sets from government agencies that make current data accessible to schools. A few years ago when Hurricane Bob ravaged the east coast, middle school students used digital satellite images and National weather service maps to track the storms and determine the multiple forces that interact to drive hurricanes across the face of the planet.

Kennedy and Chavkin (1993), described how a Texas school district uses fiber-optic technology in a partnership program to provide instruction in higher mathematics to educationally disadvantaged students called PATH [Partnership for Access to Higher Mathematics] focus on real world application that require quantitative and /or algebraic solutions. The lessons are designed so that the topics are connected across units. Besides the tutorial program using ITV(interactive television) students also get hands on experience from lessons in the regular class when they interact with college students. The effectiveness of this method was proven when PATH students scored significantly higher in the end of term algebra test than a comparable group of students in regular algebra classes.

2.3.4 Using ICTs for Collaborative Learning

Studies have demonstrated that telecommunications is particularly valuable for collaborative work by students. Researchers have found that children collaborate more frequently on computer tasks than they do when they are drawing or writing with paper and pencil. This sort of collaboration encourages the exchange of ideas and creates a more positive classroom. It also provides authentic audience for their work.

Studies by Riel (1989) showed the power of the audience effect with a controlled study among middle school students. Two groups of Israeli seventh-graders wrote essays about themselves. One group wrote for a mid-term grade, the other group wrote for an ungraded exchange with American students. The students' teachers confidently predicted that essays written for a grade would be higher quality than the others, but when these teachers rated their essays their evaluation showed the opposite. Essays written for the distant audience were significantly higher quality in all categories, with most marked differences in content, organization and language use.

Another study by Bos (1996) claimed that an authentic audience can lead to better student work in Science because it will lead students to explain more fully and think more deeply about the data they gather. He edited a newsletter that was sent out to approximately 100 science classrooms in Michigan, USA. One of the purposes of this newsletter was to create an authentic audience for student work. One report from students in Southwestern Michigan, who as part of their Science class investigation of their local stream, had discovered unacceptably high levels of a contaminant. The students' report told the story of the work they had done, their contact with the Department of Natural Resources and the hypotheses that led them to perform tests in various places. Their first

report was breezy and entertaining, but was short on scientific data. They were asked to revise their report and were told that their peer audience were also involved in water quality testing and would be interested in more details of the process. The revised version explained the test more completely, that is in both depth and content. This was driven by the perceived role of the authentic audience.

Communicating via e-mail to real audiences has been most beneficial to students learning foreign language. According to Silva, Meagher, Valenzuela & Crenshaw (1996), providing language students contact with real audiences and immediate feedback from native speakers of the language to be learnt produces results not obtainable through other methods. When students exchange ideas with students of different cultures, they express their ideas in the target language in terms that would be more culturally relevant to their distant friends. Correspondence allows for more complete explanations and gives others the opportunity to read authentic texts.

2.3.5 Electronic Field Trips

Morden (1994) reports that students are learning in an engaging way with Crossroads to the World project. Morden, who is a teacher from Altoona, Pennsylvania teaches 7th and 8th graders by providing the means to experience and appreciate the world's cultural, historical and geographical differences and similarities. Basic to the project is an integration of technology and the use of an extended real life simulation. Students simulate a trip and are involved in every aspect of the journey from planning itineraries and budgets to documenting their travels to gain firsthand information from their faraway friends about their communities by accessing the Internet. Students sent both business and personal letters to other schools, chambers of commerce, tourist bureau and

embassies. While collecting data, students learnt about the world opening possibilities of telecommunication, the use of databases as organizational tools and the wonders of CD-ROM and laser disc technology. In preparing their travel budget they used a spread sheet. They solved problems when they faced real-life predicaments as challenges and also as opportunities to apply skills and knowledge. The travelers interacted with their friends at their destinations through e-mail. Students documented their travels with two types of scrapbooks, a traditional scrapbook and a HyperScrapbook which includes not only text but also graphics animation and sound. In this sort of learning, ICTs provide the opportunity for going on electronic excursions at a lower cost and less physical risk for the student. At the same time it enables the students to get involved, plan and create all of which requires higher order thinking skills.

The County Public Schools Fairfax Network in collaboration with outside funders like NASA and the National Science Foundation have produced Electronic Fieldtrips, which allows students to explore topics that are not properly addressed in the texts. Teachers receive a packet of print material with suggested hands-on class activities to use before the Electronic Fieldtrip. A 30-minute pretaped program presents background in preparation for the live event in an hour-long interactive teleconference with working experts. The programs are seamed so that there are appropriate stops for classroom activities (Scherer, 1994).

As can be seen, this review has cited only examples of some of the methods that have successfully integrated ICTs in the classroom to achieve higher order thinking skills. There are myriad ways in which an innovative and creative teacher can use ICTs in the

classroom to promote higher order thinking skills. These methods need not be used in isolation. For example, in carrying out projects it can start off by inquiry and then lead on to problem solving to find the answers in a collaborative learning environment. ICTs makes it possible to simulate situations in which analytical, problem solving and decision-making skills can be taught to students. The use of ICTs in the classroom can stimulate and sustain students' interest in ways that traditional teaching methods do not. However, these classroom activities need to be carefully structured by the teacher in order to promote higher order thinking.

2.4 Problems faced by teachers in integrating ICTs for higher order thinking skills

Despite the optimistic view of the possibilities of the ICTS in promoting higher order thinking skills, expecting teachers to rapidly accept and adapt these teaching methods is unrealistic.

Byron (1997) discussed several reasons why ICTs have so far failed to revolutionize instructional processes or to have the profound impact on the improvement of educational quality. Some of the reasons were as follows:

- Limited availability and accessibility of ICTs in schools. Most western countries report a student computer ratio in schools of between 14:1 and 10:1 and this varies between levels and types of schools.
- The hardware and software constitute a very expensive resource for schools even in industrialized countries where the necessary infrastructure for their installation exists.
- The internet being a very recent development is less available in the classroom and this deprives the schools of a very valuable teaching /learning resource.

- Teachers resist the implementation of ICTs in the classroom for reasons like, their unfamiliarity with the technologies; the additional time and effort necessary for their effective use; the feeling that ICTs pose a threat to their professional role and image.
- Inadequate teacher training in using ICTs because of high costs.
- The limited availability of suitable software. Educational CD-ROMs are often not curriculum based and teachers have to spend a lot of time devising appropriate ways to incorporate them into the regular curriculum.
- Almost complete dominance of English over other languages in the computer field appears to be an obstacle for widespread use of ICTs in developing countries.

Hannafin & Savenye (1993,p.28) examined the changing role of the teacher who uses the computer and the resistance to their new role.

> The teacher's role does not change simply by using the computer in the classroom. The change occurs only to the extent to which a shift of responsibility to the learners occurs. The more responsibility and freedom given to the learners, the greater the shift in the teacher's role.

Hannafin & Savenye argued that ICTs have failed in activities involving higher order thinking skills because teachers are contented in using the computer for low-level activities like in drill and practice exercises that do not affect the traditional teacher-centered approach to learning. In this way, teachers still select instructional material and control the activity which is consistent with their views of learning.

An alternative view offered by Tobin and Dawson (1992) cited in Hannafin & Savenye (1993) explains that teachers have been expected by society to "control the class" so an innovation like ICTs that empowers the students is in conflict with the expectations of the teacher.

Veen (1993) undertook four case studies on the use of computers by teachers and found that teachers have strong beliefs with respect to the content of their subject matter as well as its pedagogy. Teachers only adopt new media if they can use them in accordance with their existing beliefs and practices. They tried to fit ICTs into pedagogical approaches consistent with their beliefs and skills. Although the teachers in the study tried to enhance their computer skills, their beliefs were hardly changed by the influence of ICTs.

2.5 Implications

ICTs can promote teaching of higher order thinking skills because it has the ability to arouse the interest of students, ease communications among teachers and students for sharing ideas, makes available new resources and has the potential to develop new relationships all over the world.

There are great advantages to carrying out task based activities using inquiry based learning, project work, solving problems and collaborating. Students can work in small groups in which all members share a common goal and are responsible for optimizing both their own and other group members' learning. In the process they develop skills in analyzing, applying, synthesizing and evaluating information.

The presence of real audience and the spiraling of learning activities that permitted students to interact repeatedly while carrying out aspects of real world tasks contributed to student success.

It can also be implied that the general employment of ICTs in the classroom will change

the attitude of teachers towards students as learning becomes student centered and the students more responsible and independent.

Even though the effectiveness of ICTs in education for higher order thinking skills is acknowledged , teachers have not been able to fully utilize it in the classrooms due to problems like high costs, lack of training and teachers' own resistance to change.

In conclusion, it can be said that to benefit from the full effects of ICTs in the classroom, system wide changes need to be made. These changes entail new designs of the whole curriculum and socially based inquiry opportunities; interdisciplinary; authentic learning tasks and changing roles of teachers. For Malaysia, there is the hope of these changes being made with the introduction of the Smart School concept which emphasizes the role of ICTs in education.