CHALLENGES FOR EDUCATIONAL TECHNOLOGY

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Preface

Challenges for educational technology encompass a myriad of obstacles that educators, policymakers, and stakeholders must navigate to effectively integrate technology into educational settings. One significant challenge is the digital divide, which refers to disparities in access to technology and digital resources among different socioeconomic and demographic groups. Bridging this gap requires concerted efforts to ensure equitable access to technology and connectivity, particularly in underserved communities where access to technology may be limited.

Moreover, resistance to change and technological adoption poses a formidable challenge to the effective implementation of educational technology initiatives. Educators may encounter skepticism or reluctance among colleagues or administrators, hindering the adoption of innovative pedagogical practices and digital tools. Overcoming resistance to change involves fostering a culture of innovation, providing professional development opportunities, and demonstrating the value of technology in enhancing teaching and learning outcomes.

Additionally, sustainability and scalability are significant challenges in educational technology implementation. Many technology initiatives are pilot projects or short-term initiatives that struggle to be scaled up or sustained over time. Addressing these challenges requires strategic planning, investment in infrastructure, and long-term commitment from stakeholders to support ongoing innovation and improvement in educational technology integration.

Moreover, the rapid pace of technological advancement poses challenges for educators in keeping pace with evolving technologies and trends. Educators must continually update their skills and knowledge to effectively integrate new technologies into teaching and learning practices. Additionally, the integration of technology into curriculum and instruction requires thoughtful planning and alignment with learning objectives to ensure meaningful and effective use of technology in educational settings.

Addressing the challenges for educational technology requires collaborative efforts, strategic planning, and a commitment to equity, innovation, and quality in educational practice. By overcoming barriers to access, adoption, quality assurance, sustainability, and professional development, educators and policymakers can harness the full potential of educational technology to enhance teaching and learning outcomes and prepare students for success in a digital world.

The book on Challenges for Educational Technology provides insights into the obstacles and opportunities shaping the integration and implementation of technology in education, offering strategies for overcoming hurdles and maximizing its potential.

–Author

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Theories and Practices in Educational Technology

Three main theoretical schools or philosophical frameworks have been present in the educational technology literature. These are Behaviourism, Cognitivism and Constructivism.

Each of these schools of thought are still present in today's literature but have evolved as the Psychology literature has evolved.

BEHAVIOURISM

This theoretical framework was developed in the early 20^{th} century with the animal learning experiments of Ivan Pavlov, Edward Thorndike, Edward C. Tolman, Clark L. Hull, B.F. Skinner and many others.

Many psychologists used these theories to describe and experiment with human learning. While still very useful this philosophy of learning has lost favour with many educators.

Skinner's Contributions

B.F. Skinner wrote extensively on improvements of teaching based on his functional analysis of Verbal Behaviour and wrote "The Technology of Teaching", an attempt to dispel the myths underlying contemporary education as well as promote his system he called programmed instruction.

Ogden Lindsley also developed the Celeration learning system similarly based on behaviour analysis but quite different from Keller's and Skinner's models.

COGNITIVISM

Cognitive science has changed how educators view learning. Since the very early beginning of the Cognitive Revolution of the 1960s and 1970s, learning theory has undergone a great deal of change. Much of the empirical framework of Behaviourism was retained even though a new paradigm had begun.

Cognitive theories look beyond behaviour to explain brain-based learning. Cognitivists consider how human memory works to promote learning. After memory theories like the Atkinson-Shiffrin memory model and Baddeley's Working memory model were established as a theoretical framework in Cognitive Psychology, new cognitive frameworks of learning began to emerge during the 1970s, 1980s, and 1990s. It is important to note that Computer Science and Information Technology have had a major influence on Cognitive Science theory. The Cognitive concepts of working memory (formerly known as short term memory) and long term memory have been facilitated by research and technology from the field of Computer Science.

Another major influence on the field of Cognitive Science is Noam Chomsky. Today researchers are concentrating on topics like Cognitive load and Information Processing Theory. In addition, psychology as applied to media is easily measured in studying behaviour. The area of media psychology is both cognative and affective and is central to understanding educational technology.

CONSTRUCTIVISM

Constructivism is a learning theory or educational philosophy that many educators began to consider in the 1990s. One of the primary tenets of this philosophy is that learners construct their own meaning from new information, as they interact with reality or others with different perspectives.

Constructivist learning environments require students to utilise their prior knowledge and experiences to formulate new, related, and/or adaptive concepts in learning. Under this framework the role of the teacher becomes that of a facilitator, providing guidance so that learners can construct their own knowledge.

Constructivist educators must make sure that the prior learning experiences are appropriate and related to the concepts being taught. Jonassen (1997) suggests "well-structured" learning environments are useful for novice learners and that "ill-structured" environments are only useful for more advanced learners. Educators utilising technology when teaching with a constructivist perspective should choose technologies that reinforce prior learning perhaps in a problem-solving environment.

MEANING OF EDUCATIONAL TECHNOLOGY

Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources. The term educational technology is often associated with, and encompasses, instructional theory and learning theory. While instructional technology is "the theory and practice of design, development, utilisation, management, and evaluation of processes and resources for learning," according to the Association for Educational Communications and Technology (AECT) Definitions and Terminology Committee, educational technology includes other systems used in the process of developing human capability. Educational technology includes, but is not limited to, software, hardware, as well as Internet applications, such as wikis and blogs, and activities. But there is still debate on what these terms mean.

Technology of education is most simply and comfortably defined as an array of tools that might prove helpful in advancing student learning and may be measured in how and why individuals behave. Educational Technology relies on a broad definition of the word "technology." Technology can refer to material objects of use to humanity, such as machines or hardware, but it can also encompass broader themes, including systems, methods of organisation, and techniques. Some modern tools include but are not limited to overhead projectors, laptop computers, and calculators. Newer tools such as "smartphones" and games (both online and offline) are beginning to draw serious attention for their learning potential. Media psychology is the field of study that applies theories in human behaviour to educational technology.

The word technology for the sister fields of Educational and Human Performance Technology means "applied science." In other words, any valid and reliable process or procedure that is derived from basic research using the "scientific method" is considered a "technology." Educational or Human Performance Technology may be based purely on algorithmic or heuristic processes, but neither necessarily implies physical technology. The word technology comes from the Greek "techne" which means craft or art. Another word, "technique," with the same origin, also may be used when considering the field Educational Technology. So Educational Technology may be extended to include the techniques of the educator.

A classic example of an Educational Psychology text is Bloom's 1956, *Taxonomy of Educational Objectives*. Bloom's Taxonomy is helpful when designing learning activities to keep in mind what is expected of—and what are the learning goals for—learners. However, Bloom's work does not explicitly deal with educational technology *per se* and is more concerned with pedagogical strategies.

An Educational Technologist is someone who transforms basic educational and psychological research into an evidence-based applied science (or a technology) of learning or instruction. Educational Technologists typically have a graduate degree (Master's, Doctorate, Ph.D., or D.Phil.) in a field related to educational psychology, educational media, experimental psychology, cognitive psychology or, more purely, in the fields of Educational, Instructional or Human Performance Technology or Instructional Systems Design. But few of those theorists would ever use the term "educational technologist" as a term to describe themselves, preferring terms such as "educator."

The transformation of educational technology from a cottage industry to a profession is discussed by Shurville, Browne, and Whitaker.

HISTORY OF EDUCATIONAL TECHNOLOGY

Educational technology in a way could be traced back to the emergence of very early tools, *e.g.*, paintings on cave walls. But usually its history starts with educational film (1900s) or Sidney Pressey's mechanical teaching machines in the 1920s.

The first large scale usage of new technologies can be traced to US WWII training of soldiers through training films and other mediated materials. Today, presentation-based technology, based on the idea that people can learn through aural and visual reception, exists in many forms, *e.g.*, streaming audio and video, or PowerPoint presentations with voice-over. Another interesting invention of the 1940s was hypertext, *i.e.*, V. Bush's memex.

The 1950s led to two major, still popular designs. Skinners work led to "programmed instruction" focusing on the formulation of behavioural objectives, breaking instructional content into small units and rewarding correct responses early and often. Advocating a mastery approach to learning based on his taxonomy of intellectual behaviours, Bloom endorsed instructional techniques that varied both instruction and time according to learner requirements. Models based on these designs were usually referred to as computer-based training" (CBT), Computer-aided instruction or computer-assisted instruction (CAI) in the 1970s through the 1990s. In a more simplified form they correspond to today's "e-contents" that often form the core of "e-learning" set-ups, sometimes also referred to as web-based training (WBT) or e-instruction.

The course designer divides learning contents into smaller chunks of text augmented with graphics and multimedia presentation. Frequent Multiple Choice questions with immediate feedback are added for self-assessment and guidance. Such e-contents can rely on standards defined by IMS, ADL/SCORM and IEEE.

The 1980s and 1990s produced a variety of schools that can be put under the umbrella of the label Computer-based learning (CBL). Frequently based on constructivist and cognitivist learning theories, these environments focused on teaching both abstract and domain-specific problem solving. Preferred technologies were micro-worlds (computer environments where learners could explore and build), simulations (computer environments where learner can play with parameters of dynamic systems) and hypertext.

Digitised communication and networking in education started in the mid 80s and became popular by the mid-90's, in particular through the World-Wide Web (WWW), e-mail and Forums. There is a difference between two major forms of online learning. The earlier type, based on either Computer Based Training (CBT) or Computer-based learning (CBL), focused on the interaction between the student and computer drills plus tutorials on one hand or micro-worlds and simulations on the other. Both can be delivered today over the WWW. Today, the prevailing paradigm in the regular school system is Computer-mediated communication (CMC), where the primary form of interaction is between students and instructors, mediated by the computer. CBT/CBL usually means individualised (self-study) learning, while CMC involves teacher/tutor facilitation and requires scenarisation of flexible learning activities. In addition, modern ICT provides education with tools for sustaining learning communities and associated knowledge management tasks. It also provides tools for student and curriculum management.

In addition to classroom enhancement, learning technologies also play a major role in full-time distance teaching. While most quality offers still rely on paper, videos and occasional CBT/CBL materials, there is increased use of e-tutoring through forums, instant messaging, video-conferencing, *etc.* Courses addressed to smaller groups frequently use blended or hybrid designs that mix presence courses (usually in the beginning and at the end of a module) with distance activities and use various pedagogical styles (*e.g.*, drill and practise, exercises, projects, *etc.*). The 2000s emergence of multiple mobile and ubiquitous technologies gave a new impulse to situated learning theories favouring learning-in-context scenarios. Some literature uses the concept of integrated learning to describe blended learning scenarios that integrate both school and authentic (*e.g.*, workplace) settings.

INSTRUCTIONAL TECHNIQUE AND TECHNOLOGIES

"Children and young people are growing up in a vastly changing context. No aspect of their lives is untouched by the digital era which is transforming how they live, relate and learn." Some examples of these changes in the classroom include Problem Based Learning, Project-based Learning, and Enquiry-based learning. Together they are active learning educational technologies used to facilitate learning. Technology which includes physical and process applied science can be incorporated into project, problem, enquiry-based learning as they all have a similar educational philosophy. All three are student centered, ideally involving real-world scenarios in which students are actively engaged in critical thinking activities. The process that students are encouraged to employ (as long as it is based on empirical research) is considered to be a technology. Classic examples of technologies used by teachers and Educational Technologists include Bloom's Taxonomy and Instructional Design.

BENEFITS OF EDUCATIONAL TECHNOLOGY

Educational technology is intended to improve education over what it would be without technology.

Some of the claimed benefits are listed below:

- *Easy-to-access course materials:* Instructors can post the course material or important information on a course web site, which means students can study at a time and location they prefer and can obtain the study material very quickly
- *Student motivation:* Computer-based instruction can give instant feedback to students and explain correct answers. Moreover, a computer

is patient and non-judgemental, which can give the student motivation to continue learning. Who studies the effectiveness of computers used for instruction, students usually learn more in less time when receiving computer-based instruction and they like classes more and develop more positive attitudes towards computers in computer-based classes. The American educator, Cassandra B. Whyte, researched and reported about the importance of locus of control and successful academic performance and by the late 1980s, she wrote of how important computer usage and information technology would become in the higher education experience of the future.

- *Wide participation:* Learning material can be used for long distance learning and are accessible to a wider audience
- *Improved student writing:* It is convenient for students to edit their written work on word processors, which can, in turn, improve the quality of their writing. The students are better at critiquing and editing written work that is exchanged over a computer network with students they know
- *Subjects made easier to learn:* Many different types of educational software are designed and developed to help children or teenagers to learn specific subjects. Examples include pre-school software, computer simulators, and graphics software
- *A structure that is more amenable to measurement and improvement of outcomes:* With proper structuring it can become easier to monitor and maintain student work while also quickly gauging modifications to the instruction necessary to enhance student learning.
- *Differentiated Instruction*: Educational technology provides the means to focus on active student participation and to present differentiated questioning strategies. It broadens individualised instruction and promotes the development of personalised learning plans. Students are encouraged to use multimedia components and to incorporate the knowledge they gained in creative ways.

SCOPE OF EDUCATIONAL TECHNOLOGY

By scope of educational technology we mean the jurisdiction, the limits or the boundaries within which it works. It needs demarcation of the boundaries within which the process of education can go on. Being a fast growing modern discipline it is almost practical all through and is expanding with a tremendous speed, aiming at all- round development in the area of education. National Policy on Education (1986), recommends that, “Educational Technology will be employed in the spread of useful, information, the training and retraining of teachers, to improve quality, sharpen awareness of art and culture, inculcate abiding values, *etc.*, both in the formal and non-formal sectors. Maximum use will be made of the available infrastructure.”

The scope of Educational Technology can be accessed from the following points:

- *Determination of Objectives*: Educational Technology provides different methods and techniques for writing instructional objectives in behavioural terms such as Bloom Taxonomy Magar's Approach and RCEM Approach. The needs and requirements of the people and hence education need be revised from moment to moment. Educational technology helps in fixing-up the right objectives in the light of the changed circumstances and changed environment.
- *Improvement in Teaching Learning Process*: It helps in improving the teaching learning process and makes it more purposive. It tries to discuss the concept of teaching, analysis of teaching process, variables of teaching, phases and levels of teaching, principles of teaching, maxims of teaching and relationship between teaching and learning.
- *Development of Teaching Learning Material*: Teaching learning materials are also as important as anything else in the teaching learning process. In this age of science and technology, the materials of teaching cannot be unscientific. Everything of the society including values of life need be reflected in the materials. Only right type of material will be able to modify the behaviour of the learner suitably making him a fit person for the society.
- *Improvement in Teaching Training*: The change of environment with ne curriculum and new materials need be handled by the teachers. The teachers equipped with old strategies and methodologies of teaching will remain misfits. Right type of training to the teachers is the need of the hour. Educational Technology can render its valuable help in the training of teachers also. The use of video tapes and close circuit T.V. will help the teachers to remodel and reshape their teaching behaviours suitably. It includes micro teaching, simulated teaching, term-teaching, teacher effectiveness, modification of teacher-behaviour, class-room interaction and interaction analysis, *etc.*
- *Development of Teaching Learning Strategies*: A strategy plays an important role in the hands of a teacher in every learning situation. The strategy has to be the right one which should be according to the materials and is able to bring about effective teaching- learning. The different strategies are being evolved by educational technology. The knowledge of those strategies is a must for every teacher. Then only the teacher will be able to do justice to their jobs. It tries to describe the ways and means of discovering selecting and developing suitable strategies and tactics of teaching in terms of optimum learning and available teaching-learning resources; the availability of the different types of teaching methods, devices and models of teaching-their appropriate selection and use for the optimum results.
- *Proper Use of Audio Visual Aids*: Audio Visual aids have always played an important role in the teaching-learning process. They need be used

according to the times. The software aids, the hardware aids, the computer and other such appliances, equipment, *etc.*, have to be used in the present type of teaching-learning environment. Computer assisted instructions will help the learner as well as the teacher to achieve the goals of education more conveniently.

- *Utilisation of the Sub-System of Education*: Educational Technology considers education as a system operating in a systematic and scientific way for the achievement of educational objectives. For the coverage of its systematic approach, it tries to include the topics dealing with the theory and principles of a system approach, explaining education as a system, its different sub-systems in terms of input and output. It is helpful in solving scientifically educational administrative problems with the help of system analysis.
- *Development of Curriculum*: Educational Technology is concerned with the designing of a suitable curriculum for the achievement of the desired objectives. It is helpful in describing the ways and means of the selection of suitable learning experiences, organisation of the contents in a suitable framework in order to bring better results. It provides the scientific foundation to education as well as develops theories of teaching and learning.
- *Proper Use of Hardware and Software*: These days' hardware and software are playing an effective role in the attainment of educational objectives. Educational Technology helps in the proper use of these aids. It tries to describe these resources in terms of their specific functions, their solution, proper handling and maintenance.
- *Provides Feedback*: It provides an appropriate feedback to the learners as well as teachers for bringing necessary improvement at the preparatory and implementation stages of their specific acts. For this purpose, educational technology discusses the ways and means of suitable evaluation techniques, their planning, development selection and appropriate use in relation to the objectives of teaching- learning system. In this way Educational Technology is concerned with all those who are connected in any way, directly or indirectly, to the processes and products of education. It teaches the teachers the art of teaching, the learners the science of teach the educational planners the structure of planning and administrators or managers the skill of managing or administering the task of teaching and learning. It works for the individualisation of instructions as well for improving the group dynamics of the class-room.

IMPORTANCE OF TECHNOLOGY

In the past, learning and education simply meant face-to-face lectures, reading books or printed handouts, taking notes and completing assignments generally in the form of answering questions or writing essays. In short; education, learning and teaching were considered impossible without a teacher, books and chalkboards. Today, education and training have taken on a whole new meaning. Computers are an essential part of every classroom and teachers are using DVDs, CD-ROMs and videos to show students how things work and operate. Students can interact with the subject matters through the use of such web based tools and CD-ROMs. Moreover, each student can progress at his/her own pace.

HOW IMPORTANT IS TECHNOLOGY IN EDUCATION

The role of technology in the field of education is four-fold: it is included as a part of the curriculum, as an instructional delivery system, as a means of aiding instructions and also as a tool to enhance the entire learning process. Thanks to technology; education has gone from passive and reactive to interactive and aggressive.

Education is essential in corporate and academic settings. In the former, education or training is used to help workers do things differently than they did before. In the latter; education is geared towards creating curiosity in the minds of students. In either case, the use of technology can help students understand and retain concepts better.

FACTORS THAT HELP STUDENTS LEARN BETTER

Research has shown, time and again, that students learn best when they are engaged. Through the use of technology, students can become active participants as opposed to passive ones where they simply receive instructions or information. Trust is another factor that enhances the learning ability of students. With the help of technology, teachers can establish credibility in what they are teaching.

Web based tools can be used for providing demonstrations and examples that can help students establish credence in what they are learning.

TECHNOLOGY ALLOWS DISTANCE LEARNING

Perhaps the greatest impact of technology in the field of learning is its ability to help several people learn simultaneously from different locations. Learners are not required to gather at a predetermined time or place in order to learn and receive instructions and information. All one needs is a computer connected to a modem (or with a CD drive); these tools can literally deliver a ‘classroom’ in the homes and offices of people.

TECHNOLOGY ALLOWS GROUP LEARNING

There are naysayers who argue that distance learning of this sort cannot help students receive the support of traditional group-based learning. For proving this theory wrong, technology has helped provide distance learners with online communities, live chat rooms and bulletin boards. All these allow students to collaborate and communicate even though they are isolated in their own space.

TECHNOLOGY ALLOWS INDIVIDUAL PACING

Multimedia tools, on-line and CD-ROM based training have helped eliminate the need for an instructor-based lesson plans. Students who grasp concepts faster proceed and move along, without being held back by ones who need more time and help for learning. Such individual pacing is beneficial to all.

TECHNOLOGY HELPS LOWER TRAINING COSTS AND INCREASES PRODUCTIVITY

Another benefit of using technology to reach many students in shorter time is lowering training costs. Corporate and academic Institutions can reduce their costs of delivering lessons to students on a per-student basis. Moreover, technology produces quantifiable results and allows students to put into practice this information quickly and with better results. Through the use of technology, students can considerably save time and increase their productivity. Both these points justify the higher costs of advanced technological tools.

ROADBLOCKS IN THE USE OF TECHNOLOGY IN LEARNING

Naturally, for education technology to have a positive impact on students, it should be designed and prepared well. Tools used for disseminating information must be developed with students in mind. There are also factors like lack of computer/technology literacy to be considered. Schools and businesses must bear in mind that education technology is simply a tool and its success depends largely on the amount of planning that goes into it. Using education technology can be a right choice as long as all such factors are considered.

EDUCATIONAL TECHNOLOGY IN THE CLASSROOM

There are various types of technologies currently used in traditional classrooms.

Among these are:

- *Computer in the classroom:* Having a computer in the classroom is an asset to any teacher. With a computer in the classroom, teachers are able to demonstrate a new lesson, present new material, illustrate how to use new programmes, and show new web sites.
- *Class web site*: An easy way to display your student's work is to create a web page designed for your class. Once a web page is designed, teachers can post homework assignments, student work, famous quotes, trivia games, and so much more. In today's society, children know how to use the computer and navigate their way through a web site, so why not give them one where they can be a published author. Just be careful as most districts maintain strong policies to manage official web sites for a school or classroom. Also, most school districts provide teacher webpages that can easily be viewed through the school district's web site.

- *Class blogs and wikis*: There are a variety of Web 2.0 tools that are currently being implemented in the classroom. Blogs allow for students to maintain a running dialogue, such as a journal, thoughts, ideas, and assignments that also provide for student comment and reflection. Wikis are more group focused to allow multiple members of the group to edit a single document and create a truly collaborative and carefully edited finished product.
- *Wireless classroom microphones*: Noisy classrooms are a daily occurrence, and with the help of microphones, students are able to hear their teachers more clearly. Children learn better when they hear the teacher clearly. The benefit for teachers is that they no longer lose their voices at the end of the day.
- *Mobile devices*: Mobile devices such as clickers or smartphone can be used to enhance the experience in the classroom by providing the possibility for professors to get feedback.
- *Interactive Whiteboards*: An interactive whiteboard that provides touch control of computer applications. These enhance the experience in the classroom by showing anything that can be on a computer screen. This not only aids in visual learning, but it is interactive so the students can draw, write, or manipulate images on the interactive whiteboard.
- *Digital video-on-demand*: Replacement of hard copy videos (DVD, VHS) with digital video accessed from a central server (*e.g.,* SAFARI Montage). Digital video eliminates the need for in-classroom hardware (players) and allows teachers and students to access video clips immediately by not utilising the public Internet.
- *Online media*: Streamed video web sites can be utilised to enhance a classroom lesson (*e.g.,* United Streaming, Teacher Tube, *etc.*)
- *Online study tools*: Tools that motivate studying by making studying more fun or individualised for the student (*e.g.,* Study Cocoa)
- *Digital Games*: The field of educational games and serious games has been growing significantly over the last few years. The digital games are being provided as tools for the classroom and have a lot of positive feedback including higher motivation for students.

There are many other tools being utilised depending on the local school board and funds available.

These may include: digital cameras, video cameras, interactive whiteboard tools, document cameras, or LCD projectors:

- *Podcasts*: Podcasting is a relatively new invention that allows anybody to publish files to the Internet where individuals can subscribe and receive new files from people by a subscription. The primary benefit of podcasting for educators is quite simple. It enables teachers to reach students through a medium that is both “cool” and a part of their daily lives. For a technology that only requires a computer, microphone and internet connection, podcasting has the capacity of advancing a student’s education beyond the classroom. When students listen to the podcasts of other students as well as their own, they can quickly demonstrate their capacities to identify and define “quality.” This can be a great tool for learning and developing literacy inside and outside the classroom. Podcasting can help sharpen students’ vocabulary, writing, editing, public speaking, and presentation skills. Students will also learn skills that will be valuable in the working world, such as communication, time management, and problem-solving.

Although podcasts are a new phenomenon in classrooms, especially on college campuses, studies have shown the differences in effectiveness between a live lecture versus podcast are minor in terms of the education of the student.

THE NATIONAL EDUCATION TECHNOLOGY STANDARDS (NETS)

Every lesson is based upon learning objectives. A teacher generates learning objectives in order to help students achieve mastery in the content standards required for a particular curriculum area by the district or the state. Sometimes, the standards come from professional educational organizations such as the International Society for Technology in Education (ISTE). ISTE developed standards for technology education called the National Educational Technology Standards (NETS) that set the bar for schools across the nation. According to the ISTE website, as of May 19, 2004, 48 out of 50 states, and the District of Columbia, have adopted, adapted, or referenced the National Educational Technology Standards for Teachers, Students, and Administrators in their states’ technology plans, within their curriculum development, and in other state documents. The National Educational Technology standards explain what teachers, administrators, and students should know and be able to do with regard to technology. Use the NETS for Teachers to guide your own professional development. The NETS for Teachers will tell you what you need to know to successfully integrate technology into your classroom. Use the NETS for Students in conjunction with your district or state technology standards to plan your lessons and assess your students.

NEED FOR TECHNOLOGY STANDARDS

At a time when most states are requiring teachers to adapt to standard-driven education in all subject areas, there is a call for technology to be included as well. The CEO Forum on Education and Technology, a partnership of business and education leaders founded in 1996, spent five years analyzing how well the educational field integrated technology into its curriculum. Agreeing that there was a critical need for students to be on the forefront of the newest technology available, they offered the following recommendations to federal policymakers.

The policy paper requested that the Department of Education include technology into standards-based curriculum, expand federal support for technology integration, and continue to research the development and dissemination of technological advances. “The Department of Education should establish accountability models for the inclusion of 21st century skills as an additional discipline". By creating the accountability that standards provide, students receive the necessary skills to become global citizens for the future.

Jan Hawkins, who served as director for a nonprofit research group called the Center for Children and Technology in New York, noted that there is a need for the schools to catch up with technology use in the business world (Hawkins, 1997). She made an appeal for accountability because of the types of technology-based jobs available at that time. The rise of the technology-based job market has only grown since then. The inclusion of technology standards in the curriculum is indispensable to preparing students of all ages for the real world, especially as technology develops even further. This chapter takes a detailed look at the ISTE NETS for Teachers and the ISTE NETS for Students.

You will also have the opportunity to evaluate your own skills and to compare them against the standards for teachers. You will be asked to review the student standards and estimate the proficiency level of a group of students that you either work with or have worked with in the past. Before you begin reading about the ISTE NETS for Teachers and Students, assess your knowledge of the technology skills in the ISTE NETS and your knowledge of the use of technology standards in education.

CHECK YOUR KNOWLEDGE

Directions: Evaluate the accuracy of each statement below. Place a T (for True) or an F (for False) in the space provided:

- Teachers of all grade levels must design and teach technology-enhanced lessons that incorporate the student technology standards.
- Technology standards are used as guidelines to ensure that teachers and students have important technology skills.
- Teachers should remain current on their school district's Acceptable Use Policy and other ethical policies that focus on educational technology.
- PreK–12th grade students need to understand the ethical uses of technology.
- Teachers should incorporate technology as a separate time period in the school day.
- All PreK–12th grade students should be able to generate a developmentally appropriate word processor document.
- The student performance indicators, which come from the ISTE NETS for Students, should be the same for all grade levels.
- Collaboration is not an important component of the ISTE NETS for Students performance indicators for PreK–12th grade students.
- There are very few resources for teachers who are trying to develop lessons based on the ISTE NETS for Students.
- Teachers should ignore their own district or state technology standards and instead use the ISTE NETS to develop lessons and assess students

ISTE NATIONAL EDUCATION TECHNOLOGY STANDARDS (NETS) FOR TEACHERS

The International Society of Technology Educators (ISTE), with the help of a consortium of other stakeholders, developed the National Educational Technology Standards for Teachers (NETS for Teachers) in the early 1990s. The ISTE NETS for teachers was developed to ensure that educators have a solid foundation in technology in order to be effective teachers of technology.

It is ISTE's continued belief that "today's classroom teachers must be prepared to provide technology-supported learning opportunities for their students. Being prepared to use technology and knowing how that technology can support student learning must become integral skills in every teacher's professional repertoire". It is extremely important that teachers realise that there are technology standards to which they must hold themselves accountable. Let's take a closer look at the NETS for teachers.

The NETS for teachers are organized into six categories:

- Technology Operations and Concepts.
  - These standards address the teacher's understanding of basic technology issues and ability to learn about technology as it changes and develops.
- Planning and Designing Learning Environments and Experiences.
  - These standards address the teacher's ability to create effective learning environments that utilize technology.
- Teaching, Learning, and the Curriculum.
  - These standards address the teacher's ability to use appropriate strategies to maximize student learning experiences while using technology.
- Assessment and Evaluation.
  - These standards address the teacher's ability to use technology in the assessment of students.
- Productivity and Professional Practice.
  - These standards address the teacher's ability to use technology in professional activities, including further professional development and communication with colleagues, parents, and the community.
- Social, Ethical, Legal, and Human Issues.
  - These standards address the teacher's ability to adhere to the social, ethical, legal, and human issues surrounding technology use in schools. Each of the six standards areas is broken down into performance indicators that more specifically explain proficiency in that area. A complete description of the different standards, performance indicators, and performance profiles can be found on the ISTE website

MORE THAN TECHNOLOGY SKILLS

Notice that there is much more to the NETS for teachers than possessing key technology skills. To be proficient in the NETS for teachers, you must be able to plan and execute lessons involving meaningful uses of technology. You must also be able to assess student proficiency in technology and use technological tools to assess students. Furthermore, you must use technology to help manage your classroom and accomplish organizational tasks.

Finally, you must be aware and apply your understanding of the social, ethical, legal, and human issues associated with technology used in an educational setting. It is also very important that you and your students follow the guidelines and rules outlined in your school district's Acceptable Use Policy (AUP). The AUP is a document that all computer users in a school or school district, including students, must sign. By signing the document, the computer user agrees to follow the rules and ethical practices that ensure proper use of the school's or school district's computers and networks. The standards make it clear that students of all ages should abide by the appropriate guidelines. Dave and Marilyn Forest, teachers from Union City, California, recently became nationally board-certified teachers. They believe that "if we're ever going to improve the perception of teachers in the country, we'll have to start raising the standards". Both of them integrated technology into their professional activities and their curriculum in order to demonstrate that they were worthy of this highly prestigious certification. Their use of technology extended across each of the NETS mentioned above.

They videotaped many of their own lessons and used various computer programmes to organize data collection. In order to demonstrate the social science requirements to show that students make connections to the real world, one of Dave's projects involved having his history students interview someone who had lived through an important historical event. He then posted the interviews on the Internet. Marilyn developed a computer programme to help her English class relate to the literature they were reading and respond in powerful ways, such as writing a response in poetry.

Additionally, in an effort to help teachers teach technology embedded in content and not in isolation, Marilyn created curriculum programmes with computer based lesson ideas. Marilyn isn't alone. Many accomplished teachers are writing lessons for educational websites designated for teacher use. All it takes is a search engine, and any teacher can have a handful of innovative, creative, standards-based ideas at his/her fingertips. For now, start by assessing your basic technology skills to gain a clearer picture of what you can do on a computer.

Essential Computer Skills for Teachers

- Know the basic hardware components of a computer
- Use the online help function within software applications
- Understand how different passwords are generated and used
- Know about basic file structure and manipulation (*i.e.,* what a folder is and how to copy, move, and delete a file on a hard drive or disk)
- Know how to search for a file and how to select a location when saving from the Internet or an e-mail attachment

- Know the basics of the computer's operating system
- Know how to send and receive e-mail
- Know how to use the Internet
- Be able to integrate technology-based grade level/content lessons into classroom activities
- Run antivirus software
- Use a word processor and its basic functions
- Save and retrieve files
- Manage data in teacher-based productivity software (*i.e.,* grade book, attendance, *etc.*)
- Know and use proper computer terminology
- Be able to follow written and oral instructions to complete computer tasks
- Use common sense and have realistic expectations when using a computer
- Be willing to try to figure out problems that arise when using technology
- Know how to check for unplugged or loose cables
- Realise that sometimes computers do unexpected things and a reboot often fixes the problem
- Report a computer/technology problem to the person or persons who have the capability to fix it

IMPROVING YOUR PERSONAL TECHNOLOGY SKILLS

At this point, you may be wondering how you can enhance your current technology skills and learn new skills in many of the areas listed in Table 2.1. Having computers in the classroom that are ready for use may be overwhelming for you. You may desire specific training in the application of using them within your lessons.

Professional development is readily available for willing teachers. Professional development ideally should include intensive exploratory training sessions, follow-up support over time, ongoing dialogue amongst colleagues, and observation of other teachers (Hawkins, 1997).

Sometimes a group of teachers can ask the administration to bring experts to staff meetings for training. However, staff meetings frequently tend to deal with day-to-day issues rather than professional development.

Teacher expertise is a significant determinant of student success, and teachers need focused staff development to build competence in new areas. Teachers should ask about available district technology workshops. In larger districts, technology experts may be available to answer questions and address concerns with a simple phone call. A teacher may choose to take a course at the local community college as well. Technology courses are usually offered regularly throughout the year.

In an effort to tackle the technology issue head on, a teacher may want to try an online course to learn more about technology while using it. Another way to use technology in the search for learning more about it is to videotape other teachers and learn from their integration of technology. There are many books written on improving technology skills; many are even written specifically for self-professed beginners. Teachers can also use search engines (*e.g.,* Yahoo! and Google) to search the Internet for resources and further coaching.

A teacher can type" teacher technology" and find many interesting sites to explore. These sites might give technology training, as well as specific lesson plans and ideas for technology use in the classroom.

If a teacher searches the Internet for the specific content subject, such as life science, teaching- related sites will often have ways to integrate technology into the curriculum. Finally, the best resource for teachers is other teachers. Your colleagues are often enthusiastic about sharing technology ideas, advice, and experience.

GET A CLEARER PICTURE FOR LESSONS AND PROFESSIONAL DEVELOPMENT

- Identify basic hardware components (*e.g.,* monitor, keyboard, mouse, system unit, printer, scanner)
- Understand and use correct computer terminology
- Troubleshoot and repair simple hardware/software problems
- Manage files (*e.g.,* copy, move, delete)
- Search for, save, and retrieve a file
- Save files in a user-specified location (*e.g.,* downloading files from the Internet and e-mail)
- Use the online help function within software applications
- Understand how different passwords are generated and used
- Remove computer viruses and spyware
- Use word processing software (*e.g.,* Microsoft Word)
- Use spreadsheet software (*e.g.,* Microsoft Excel)
- Use Database software (*e.g.,* Microsoft Access)
- Use multimedia presentation software (*e.g.,* Microsoft PowerPoint)
- Use desktop publishing software (*e.g.,* Microsoft Publisher)
- Use instructional software (*e.g.,* Math Blaster or CCC Math)
- Use e-mail (*e.g.,* send, retrieve, create, and open attachments)
- Use a Web browser (*e.g.,* Internet Explorer or Netscape)
- Use a search engine (*e.g.,* Google or Yahoo!)
  Search the Internet for information
- Design a Web page (*e.g.,* using Microsoft FrontPage)
  Use a scanner
- Use a digital camera
- Use a video projector
- Use a handheld computer
- ISTE National Education Technology

STANDARDS (NETS) FOR STUDENTS

The NETS for students provide a vision for overall student accomplishment and a set of practical skills and knowledge for students to acquire. Think of the NETS for students as a useful tool in conjunction with your own state standards to help you plan lessons and assess your students. It is imperative to note that technology standards are not designed to be taught in isolation. The technology standards are intended to be learned, practiced, and demonstrated while students are working on content area curriculum.

The teacher should insert the technology standards directly into content area lesson plans and develop rubrics using the specific performance indicators. This is not to say that teachers will not need to explicitly teach the technology skills; only that the skills should be taught in conjunction with relevant, meaningful learning experiences as students are problem solving, investigating, and doing research. Let's take a closer look at the NETS for students.

The NETS for students are organized into six categories:

- Basic Operations and Concepts. These standards address the student's ability to demonstrate proficiency in using technology.
- Social, Ethical, and Human Issues. These standards address the student's ability to adhere to the social, ethical, legal, and human issues surrounding technology use in schools.
- Technology Productivity Tools. These standards address the student's ability to use technology to produce information in various curriculum areas.
- Technology Communication Skills. These standards address the student's ability to use technology to communicate.
- Technology Research Skills. These standards address the student's ability to use technology for research.
- Technology Problem-Solving and Decision-Making Skills.

These standards address the student's ability to use technology to resolve real, authentic problems. A complete description of the different standards, performance indicators, and performance profiles can be found on the ISTE website. Note that the standards do not list the specific skills and knowledge that students should master.

Student Profiles

ISTE developed student profiles to show what a technologically literate student has mastered at the completion of each grade-level range. The student profiles list the specific performance indicators that students should master. Some examples of the more specific technology skills are as follows. Only a few examples are presented from each of the profile areas. A student who is finishing second grade should be able to use a mouse and keyboard and use the proper vocabulary when sharing about technology.

A student who is finishing fifth grade should be able to use technology for writing and select the appropriate technology tools to approach a task. A student who is finishing eighth grade should be able to choose content-specific technology tools for learning and take part in collaborative technology-based research. A student who is finishing 12th grade should be able to make independent decisions about the use of technology and competently use online information

Technology Skills

Before you begin planning lessons, it is a good idea to think through the basic computer skills that students need by the end of each grade-level range. Use the appropriate survey from the following pages (depending on your students' grade levels) to gain a clearer picture of what your students can do on a computer. These lists do not include every skill that students should be able to perform, but they include extensive lists that will help you develop a strong idea of your students' levels.

A REMINDER ABOUT STANDARDS

It is imperative that teachers seek out information on the technology standards and skills required of students in their specific states and districts. As noted above, many states have chosen to use the NETS for student's standards. Others have created modified versions of these same standards. Still others may have written their own. Teachers of all grade levels should inquire whether their district or state has set up technology assessments or whether technology is a component of exit exams for any grade level. Technology skills build on one another, and all students are entitled to learn the appropriate skills for their grade levels as they progress in school.

DEVELOPING LESSONS USING TECHNOLOGY STANDARDS

So now you are faced with two challenges: creating lessons that engage students in worthwhile problems and projects and incorporating technology standards into those lessons. How can you provide lessons incorporating technology standards that require students to do more than regurgitate information or demonstrate a procedure shown to them? How do you create lessons involving technology in which students are engaged in solving problems, answering questions, and completing real-world tasks? Whether you are responsible for teaching the NETS for students, a version of the NETS for students, or a separate set of technology standards, you can incorporate them into engaging lessons that address the academic standards for which you are also responsible. Hawkins (1997) noted that technology-integrated lessons provide access to current primary source material, ways for students and teachers to collaborate with experts from all around the world, and opportunities for extending comprehension through multisensory experiences.

HOW DO TEACHERS ADD TECHNOLOGY INSTRUCTION TO AN ALREADY FULL SCHEDULE?

Whenever teachers are confronted with exciting new classroom ideas, the first question is always "How do I fit that in?" There is good news about adding technology to your day. It is not an extra time period of curriculum; rather, technology is incorporated into already existing content lessons. Furthermore, technology often provides the motivation for students to exert their best efforts. The increased motivation deepens retention of content, which can minimize the need to reteach material. Following are specific content area suggestions for incorporating technology into everyday lessons. These ideas are only given to provide a jumpstart of ideas. The possibilities are as endless as your creativity allows.

Math

- Use spreadsheets to compute mathematical formulas.
- Use spreadsheets to show patterns in math.
- Use graphs to show algebra and trigonometry relations and functions.
- Use e-mail to set up math tutorial relationships among students.

Science

- Use texts to debate and compare the accuracy of Internet science articles.
- Use spreadsheets to aid in the presentation of data collection.
- Use video microscopes.
- Use simulation software that relates to the given content.
- Analyse data using a computer graphing programme

Language Arts

- Create multimedia presentations to report relationships between required literatures.
- Use literature databases for research, including any available online or through school districts or local libraries.
- Debate accuracy of Internet articles about a topic of study.
- Use familiar storybooks and literature on CDROMs.
- Have students discuss major works of literature with students from other schools, districts, states, or countries via e-mail, discussion boards, or chat rooms.

Social Studies/Geography

- Use map software to locate areas of study.
- Use Internet to research places and people of study.
- Debate bias in texts and Internet articles.
- E-mail pen pals in the areas that are being studied.

Ask and Borrow

Here are some ways to develop project-based or problem based lessons using technology standards. The very best place to start is by talking to fellow teachers who already incorporate technology in meaningful ways into their teaching.

Ask them how they manage to address academic standards and technology standards at the same time. See if they have lessons they are willing to share. If the lessons you borrow are not written for your grade level, use them for ideas to develop projects for your own students. Another excellent way to find tried and true lessons is to search online. The ISTE website provides a searchable lesson database containing lessons and units designed to teach the NETS for students. The lessons in this database are also based on national curriculum standards. Each lesson cites both the NETS standards and the curriculum standards the lesson addresses.

Find this page by using a search engine such as Google or Yahoo! and the keywords "NETS lessons" or "ISTE lesson database." Once you find the database, search it by grade level, subject, and/or keywords. Also search for lessons online in other ways. Use a search engine and keywords that pertain to what you are looking for. For example, if you are a second-grade teacher who wants to incorporate technology into your science lessons, try a search using the keywords "second-grade science lessons technology."

BIT BY BIT: INCORPORATE A LITTLE TECHNOLOGY INTO AN EXISTING LESSON

The next best place to start is to take an existing unit or lesson that you have taught before and add a small technology component. Do not feel that you must cover several technology standards at once. In the same vein, do not feel that you must substantially change the lesson or unit. Add a small technology project to the lesson without changing much else. For your very first technology project, try something you feel comfortable showing students. Maybe you have used a word processor like Microsoft Word before. Think of something the students can do with a word processor that will add an interesting, meaningful task to the lesson.

For example, for a unit on the Civil War, direct students to compose a letter to a soldier or nurse. It is okay if you are not entirely sure how to use a word processor to do this. You and your students do not need to have mastered all of the technology skills involved in a project before starting. Make use of your students' abilities to figure out how to use new technology. Most likely, some of your students will be familiar with the technology you are introducing. Start by showing the students one or two key technology skills; they can learn the rest while doing the small project. It helps to pair experienced students with less experienced students. They will work together to complete the task. After you have begun adding small technology components to your lessons, it will become easier to add more. Remember to always strive to make the use of the technology meaningful.

THE POSSIBILITIES ARE ENDLESS

There are exciting things happening all around the nation because teachers are bravely incorporating technology into the curriculum. In Hana, Hawaii, special education students are using special reading computer programmes to boost reading skills and their confidence. Speech-to-text software is helping these students express their thoughts about learning when writing can be a physical hardship. The teachers are adapting the programmes to meet the individual needs of each of their special education students and seeing remarkable results. Video clubs are also popping up in schools across the nation. They give students a voice and a sense of belonging in a school system where they might not have been succeeding before.

Through this technology, students are exploring high interest subjects. Indigenous Choctaw tribal students in Mississippi are sharing poems, tribal history, folklore, and more with other students in the United States and across continents through Internet interactive websites. Students in Spearfish, South Dakota, are holding live video conferences with other students in Sakaide City, Japan. The abundance of exciting success stories should be enough to draw teachers into the quest of integrating technology into the classroom. As you gradually add further technology components to additional classroom lessons, you will find yourself meeting more of the technology standards that your district requires.

Many districts have curriculum leaders and experts who can offer ideas, equipment, and training. The next chapter will help you by exploring different types of software programmes and the types of projects that will help your students succeed in technology.

TEACHING TEACHNOLOGY

DE serves as an alternative method for delivering academic coursework to students unable to attend traditional campus-based classes.

Mielke's discussion includes the following:

- *Definition*: DE is a method of education in which the learner is physically separated from the teacher and the institution sponsoring the instruction. Originally, DE involved teachers traveling to remote sites to teach classes or teachers corresponding with students. Technology has raised the quality of individualized distance instruction.
- *Forms of DE*: There are video and audio models of DE that involve broadcast and cable television, satellites, microwaves, fibre optics, and audio graphics. The linking of computer technology via the Internet or CD-ROM with television transmission provides a new dimension to DE, and can link professors to students in a distance setting. Another form of interaction is the use of computer conferencing. This method utilizes asynchronous communication in such forms as an e-mail list group, an Internet discussion group, or other types of conferencing software.
- *Adaptability*: Traditional programmes that are heavily based in skill development and demonstration or require laboratory work can be offered in a DE format using interactive video interfaced with computers to

facilitate a hands-on learning approach. Classes that use lectures and laboratory experiences are easily adapted to a DE situation.

- *Effective teaching and learning with DE*: DE dictates changes in behaviour for both the teacher and the learner; successful students develop persistence and skills in self-directing work. Critical elements for successful distance teaching are:
  - Instructor enthusiasm (comfort in front of the camera or with the technology);
  - Organization (teaching materials must be prepared in advance);
  - Strong commitment to student interaction;
  - Familiarity with the technology used in the class format; and
  - Critical support personnel (production staff, graphic designers, and technical staff members).

Educational Principles and Technology

Driscoll discuses four principles that offer a framework to teachers for thinking about how technology can support teaching:

1. Learning *occurs* in context, including the ways technology can facilitate learning by providing real world contexts that engage learners in solving complex problems, and computer simulations and computer-based micro worlds that offer contexts for learners to explore and understand complex phenomena in a variety of subject areas;
2. Learning is *active*, including the use of brainstorming, concept mapping, or visualization software, as well as simulations that enable learners to experiment with modeling complex ideas;
3. Learning is *social*, including software that supports a networked, multimedia environment in which students collaborate on learning activities; and
4. Learning is *reflective*, including technologies that promote communication within and outside the classroom, making it easier for feedback, reflection, and revision to occur.

Multicultural Education and Technology

In recent years, multicultural education and technology have emerged as key issues in education. Marshall describes how technology can support multicultural education efforts based on the five critical dimensions of multicultural education:

1. Content integration is intended to expand the curriculum by incorporating contributions of diverse cultures into traditional disciplines of study;
2. Knowledge construction promotes critical literacy by making explicit the manners in which scholars contribute to their respective fields of study;
3. Prejudice reduction is about eliminating all forms of bigotry and involves promoting healthy personal identity devoid of the tendency to need to denigrate people who are different;

4. Equity pedagogy is about equalizing opportunities to learn, involving incorporating various strategies that attend to learning styles and intelligence types; and
5. DE (*i.e.*, everyone has access to specific courses or programmes) is one example of empowering school cultures and social structures.

Therefore, teachers at all levels accept that technology has become an integral aspect of the teaching-learning process, but it is too soon to crown the duo a perfect pair.

CRITICISM OF EDUCATIONAL TECHNOLOGY

Although technology in the classroom does have many benefits, there are clear drawbacks as well. Limited access to sufficient quantities of a technology, lack of training, the extra time required for the implementations of technology, and the apprehension associated with assessing the effectiveness of technology in the classroom are just a few of the reasons that technology is often not used extensively in the classroom. To understand educational technology one must also understand theories in human behaviour as behaviour is affected by technology.

Media Psychology is the study of media, technology and how and why individuals, groups and societies behave the way they do. The first Ph.D programme with a concentration in media psychology was started in 2002 at Fielding Graduate University by Bernard Luskin. The Media Psychology division of APA, division 46 has a focus on media psychology. Media and the family is another emerging area affected by rapidly changing educational technology.

DIGITAL DIVIDE

One of the greatest barriers of integrating technology into the school system deals with the digital divide. The concept of the digital divide was originally defined as a gap between those who have access to digital technologies and those who do not. This access is associated with age, gender, education, income, ethnicity, and geography. The first deals with the onset of integrating technology into the curriculum and the gap between the digital haves and have nots. In most cases, this form of the digital divide means that those who have access to a computer and the Internet are considered a digital have, while on the other hand, those who do not are considered a digital have not. In today's society, this is still a significant barrier to implementing technology into the curriculum because the socio-economic status of a school, and its students, will impact whether resources can be purchased and implemented in the school system. Schools that are able to provide technology within the classroom are able to expose their students to a new means of learning, while the students in lower socio-economic schools may miss out on these experiences.

As more and more people have gone online and started using the Internet for an increasing number of activities, researchers have begun to reconsider the notion of the digital divide. Some scholars offered a redefined understanding by seeing the digital divide as a complex and dynamic phenomenon that is essentially multifaced and includes technical access (the physical availability of technology) and social access (the mix of professional knowledge, economic resources, and technical skills required for effectual use of echnology). This means that even if schools and students have access to technology, the ways in which teachers use and introduce it is significant to consider. This form of the digital divide is yet another barrier because it also goes hand-in-hand with the resources the schools have and the training teachers receive. If a teacher, for example, is not well equipped and confident in utilising a form of technology, those students will miss out on gaining the valuable skills required for today's society. Another factor that plays into the digital divide, which makes it difficult to implement technology into the curriculum, is the generational digital divide. Herrington recognises that the generational divide is interpreted to mean that people on one side of the gap, including the youth, have more access and a greater ability to use new technologies than those on the other side like the adults who were born before the advent of the Internet. The generational digital divide is a common barrier because it challenges teachers to keep up with the ever-changing technology in the classroom.

Even extending beyond the classroom, by the time an individual "adopts a technology, a new one is developed, marketed, and requires a new adoption cycle". Students, who have grown up in a digital environment, may be well acquainted with the on-going process of new technological innovation but may be lacking the guidance they need in order to utilise these technologies effectively. From the teacher's perspective, this process could be an intimidating experience because something as foreign as the computer and Internet must first be learned and then taught to the students in a classroom setting. It is difficult to formulate a curriculum, which aims to integrate technology into the classroom, when the decision-makers are still in the process of learning about it themselves.

TEACHER TRAINING

Similar to learning a new task or trade, special training is vital to ensuring the effective integration of classroom technology. The current school curriculum tends to guide teachers in training students to be autonomous problem solvers. This has become a significant barrier to effective training because the traditional methods of teaching have clashed with what is expected in the present workplace. Today's students in the workplace are increasingly being asked to work in teams, drawing on different sets of expertise, and collaborating to solve problem. These experiences are not highly centered on in the traditional classroom, but are twenty-first century skills that can be attained through the incorporation and engagement with technology. Changes in instruction and use of technology can also promote a higher level of learning among students with different types of intelligence. Therefore since technology is not the end goal of education, but rather a means by which it can be accomplished, educators must have a good grasp of the technology being used and its advantages over more traditional methods. If there is a lack in either of these areas, technology will be seen as a hindrance and not a benefit to the goals of teaching.

Another major issue arises because of the evolving nature of technology. Teachers may find themselves acting as perpetual novices when it comes to learning about technology. This is because technology, including the Internet and its range of applications, is always in a state of change and teachers must attempt to keep current.

The ways in which teachers are taught to use technology is also outdated because the primary focus of training is on computer literacy, rather than the deeper, more essential understanding and mastery of technology for information processing, communication, and problem solving. New resources have to be designed and distributed whenever the technological platform has been changed. However, finding quality materials to support classroom objectives after such changes is often difficult even after they exist in sufficient quantity and teachers must design these resources on their own. The study by Harris notes that the use of random Professional Development days is not adequate enough in order to foster the much-needed skills required to teach and apply technology in the classroom. Learning, therefore, becomes and on-going process, which takes time and a strong commitment among the community of educators.

Teacher training faces another drawback when it comes to one's mindset on the integration of technology into the curriculum. The generational divide might also lead to a generational bias, whereby teachers do not feel the need to change the traditional education system because it has been successful in the past.

This does not necessarily mean it is the right way to teach for the current and future generations. Considering the fact that today's students are constantly exposed to the impacts of the digital era, learning styles, and the methods of collecting information has evolved. To illustrate this concept Jenkins states, "students often feel locked out of the worlds described in their textbooks through the depersonalised and abstract prose used to describe them," whereas games can construct worlds for players to move through and have some stake in the events unfolding. Even though technology can provide a more personalised, yet collaborative, and creative, yet informative, approach to learning, it may be difficult to motivate the use of these contemporary approaches among teachers who have been in the field for a number of years.

ASSESSMENT

Research has shown that there is a great deal of apprehension associated with assessing the effectiveness of technology in the classroom and its development of information-age skills. This is because information-age skills, also commonly referred to as twenty-first century literacies, are relatively new to the field of education. These include "the set of abilities and skills where aural, visual, and digital literacy overlap". Jenkins modifies this definition by acknowledging them as building on the foundation of traditional literacy, research skills, technical skills and critical-analysis skills taught in the classroom. Current school assessments are based on standardised tests and the ability to complete these uniform tests, regardless of one's preferred learning style. Many factors play into this observation including the strong impact of time. By using technology and learning through discovery, teachers may feel that they are not able to cover the material needed to meet the requirements of the curriculum.

Therefore, the traditional style of teaching, including the lecturing in front of the class, and a "one-size-fits-all" approach to testing is common in today's classrooms. This is a barrier because it prevents the full integration of technology into the curriculum, the ability to learn through enquiry, and the collaborative problem-solving skills, which prove to be essential traits needed in the twenty-first century.

2

Online Teaching in Computer World

Welcome to the first of at least two reports related to instruction on the Internet. The aim of this particular report, "Online Teaching in an Online World," is to understand the online learning experiences, obstacles, supports, and preferences of college instructors across a variety of institutional settings and disciplines.

Whereas this initial report focuses on the online learning needs and supports of higher education faculty, the second study, "Online Training in an Online World," addresses similar issues in the corporate training world. After detailing the survey results and conclusions, a set of recommendations are proposed related to online learning in higher education settings.

Perhaps no technology has so swiftly assumed prominence in both educational and commercial settings as the Web. In educational arenas, those who previously found higher education too expensive or physically inaccessible can now access a myriad of online information resources and materials.

Ideas and feedback from online expert guests, mentors, and peers are now available in college classes. Finnish instructors and students can collaborate with those in the United States and Korea. Online student mentoring can come from practitioners in the field, experts at the North Pole, or graduate students and colleagues down the hall. Collaborative teaming in online college settings knows no bounds, and, not surprisingly, higher education administrators have taken notice. As a result, new instructional expectations for college faculty are emerging. This survey targeted instructors who were likely to have greater experience with these new teaching methods and tools than others. This final report is intended to provide insights into the future directions of online teaching as well as to identify the gaps in tool and courseware development efforts.

PREVIOUS REPORTS

A report from the Web-based Education Commission indicates that Web technologies are increasingly used in both online and traditional classroom-based courses. This report also notes that distance learning course offerings are expected to increase from 62 per cent of four-year colleges offering some courses online in 1998 to 84 per cent of such colleges offering such online course experiences in 2002. As a result, the Commission notes that many higher education institutions are forming consortia and collaborative groups to share course materials and resources in an effort to enhance college teaching and learning.

In terms of specific Web tools, the commission reports a dramatic increase in college faculty utilizing e-mail, Web resources, course homepages, and online discussions within their courses. In fact, they report a 25 per cent increase from 1996 to 1999 in college faculty utilizing Web resources in their class syllabi.

This report also acknowledges the additional time and risk on the part of faculty who attempt to take advantage of online learning tools and activities in their courses. But why is there a risk? Higher education institutions simply do not yet have the teaching rewards, expectations, or support structures in place for promoting faculty teaching in an online world. As e-learning environments take centre stage in college programmes around the world, it is vital to determine the tools and tasks that facilitate student learning in this new context as well as to establish quality standards for such courses. A recent report from the Institute for Higher Education Policy that was commissioned by the National Education Association and Blackboard, Inc. identified 24 key benchmarks for online learning quality.

These benchmarks addressed course development guidelines, instructional material reviews, student feedback and interaction, access to library resources, technical support, student advising procedures, and the evaluation of intended learning outcomes. There are a number of other summary reports attempting to describe and evaluate the use of distance education technology in education.

Some reports speak to the challenges of teaching in an online world, including issues of compensation, time, ownership, profitability, training, technology infrastructure, and university policies. Jaffee for instance, discusses the costs of online instruction as well as the forms of resistance to such courses and programmes at both the institutional and individual level. Others point to new economic markets and opportunities. Such reports document key trends, social demographics, stakeholders, policy makers, major players, and workplace needs. Still other reports detail newly formed and tenuous partnerships and consortia. What about the instructional, psychological, and social aspects of online learning? At least one report has been commissioned to develop guidelines or benchmarks—including many instructional design guidelines—to ensure quality distance education practices.

On the social and psychological side of online learning, Joseph Walther and his colleagues point to the social issues embedded in online environments such as student social isolation and shared knowledge. In a more recent report, Bonk and Wisher summarize the research related to online collaborative tools, e-learning, the role of the instructor, and the increasing importance of learner-centred approaches to instruction.

They also suggest more than two dozen psychologically-based research opportunities in online collaboration related to principles of cognition, motivation, social interaction, and individual differences. Within the plethora of distance education reports and prophecies, the TeleLearning Network Centres of Excellence of Canada have assumed a leadership role related to online learning research. One of their key reports compares eight key post-secondary institutions offering e-learning. In this report, Massey and Curry provide a preliminary analysis of universities emerging in this field such as Stanford University, Nova Southeastern, Western Governors University, Indiana University, the University of Illinois, Open University UK, University of Phoenix Online, and California Virtual University.

They offer a competitive analysis of the courses/programmes, pedagogy, and learner support structures in place at each of these institutions. In addition, they address expansion plans, marketing, faculty, learners/clients, and course production and delivery mechanisms at each institution. As such, this particular report offers useful insights into the direction of online technologies and course delivery.

While the TeleLearning NCE is a source for online learning reports from Canada, UCLA has recently published an inaugural report on the impact of the Internet on social, political, cultural, and economic behaviour and ideas across the United States. While that research investigates Internet usage across the general population of the United States, the data in the present study focus on evaluations of Internet usage in college courses among college instructors likely to use it.

CURRENT TENSION

There is no doubt that the Internet has brought about a new forum for learning and instruction. Higher education faculty and administrators must not only understand the new technologies that present themselves, but they also must grapple with how best to utilize them for student learning. Or as Steven Gilbert recently noted, "Acquiring the knowledge and skill necessary to improve teaching and learning with technology requires faculty, support professionals, and administrators to think and behave in new ways—deep learning." The challenge, he argues, is for early adopters of technology to push at the educational frontiers in ways that help transform themselves as well as their colleagues with new insights and lifelong learning, while staying within the educational missions and resources of their respective institutions.

But on college campuses there is tension and uncertainty surrounding the use of the Internet in teaching and learning. There is also a lot of hype. Free classes mentioned one day are delayed by downturns in the economy the next. Standards and guidelines are encouraged, but too often not established. Distance learning policies created one year are revamped in the years that follow. Moreover, too many reports speak from an administrator, politician, or corporate executive viewpoint. What is often lacking is a sense of what the faculty member or instructor thinks about the online experience. As a result, few reports reflect on the pedagogical practices that lead to online learning success.

It is as if the technology alone is sufficient to build an effective environment for learning. And this, we know, is not the case. Few can doubt that Web-based teaching and learning is a growing field with rapid changes. In part, it has emerged to fill the void in training as technical skills quickly fall into obsolescence. Reskilling simply is a fact of life. Online reskilling may be a necessity as the age of learners increases and the time available for one's studies is curtailed by job and family responsibilities. Web-based courses may simply be the only viable option for many learners. The present study attempts to determine the supports and resources that college faculty have available to meet those needs. Whereas other surveys of online learning in higher education have explored areas such as technological resource availability, instructor skills and attitudes, or institutional policies, this particular study is more comprehensive by attempting to understand instructor attitudes, experiences, preferences, and online support structures, as well as prevalent pedagogical tools and practices. Given this focus, the results of this survey can perhaps help educators design more powerful e-learning environments as well as methods to teach within them. Hopefully, it will serve as a barometer for higher education institutions considering online courses and programmes as well as a guidepost for instructors first encountering online teaching in this online world.

FOCUS ON PEDAGOGICAL PRACTICES

There is no doubt that Web-based instruction offers new ways for students to collaborate and for instructors to share pedagogical ideas and practices. It is also a way to expand the resources available to students and build permanent course archives. With the emergence of the Web, it is now possible to involve practitioners, experts, and peers as online learning guides or mentors. Case-based learning can take on a new sense of authenticity as business students chat with company executives, counseling students reflect online about crisis situations faced during internships, preservice teachers peek in on the classroom management strategies of expert teachers, and medical students virtually view sophisticated operations in action.

There seem to be limitless opportunities to exploit the Web in college teaching and learning. As online learning resources accumulate and become archived, there is even a new sense of course history and legacy. Events that were delivered or that unfolded a decade or more ago can be replayed, modified, salvaged, contemplated, and debated at any time. As a result of all these new instructional opportunities, the decisions confronting the online college instructors are multiplied. Part of this is due to the complexity of these environments that often beg for quick managerial decision making one minute, technological expertise the next, and social or pedagogical intervention just a few moments later. This survey will help document some of the early pedagogical practices of those deciding to teach online, or, at least, those beginning to utilize online resources somewhere in their teaching practices.

PURPOSE OF THE STUDY

This report is based on a survey of 222 college faculty members, most of whom have been early adopters of Webbased technology in their instruction. Unlike some of the previous studies, online course quality is just one aspect of this particular report. In addition, this survey report is intended to inform administrators and courseware designers of the benefits and challenges of using Web-based learning tools in higher education settings.

It also provides suggestions about the types of tools, activities, resources, and support structures that might enhance online learning in college settings. This survey report provides descriptive information about the types of college instructors and institutions involved in typical online environments.

It has five primary goals:

- To identify the resources, tools, and activities that college instructors desire in their Web-based teaching efforts;
- To document the gaps between online teaching practices and preferences;
- To understand some of the key obstacles as well as support structures for Web-based teaching in college settings;
- To point to online learning tools and communities that might be developed to enhance teaching and learning in higher education settings; and,
- To determine who is responsible for making online learning decisions in higher education.

In effect, this study intends to document how faculty educators are being trained, supported, and rewarded for online instruction. It also seeks to determine the types of online tools and activities that faculty prefer. Additionally, this survey explores college instructor attitudes related to online learning obstacles and support.

It addresses their perceptions of controversial online learning issues such as course ownership and quality, online programme accreditation, online teaching and learning opportunities, and the general utility of the Web as a teaching and learning resource. The conclusions are intended to help those teaching in online environments as well as those developing policies and funding new online initiatives. The findings may also be useful to companies developing and evaluating online tools for distance teaching and learning.

METHODS AND DATA

METHODOLOGICAL OVERVIEW

As distance learning tensions rise in response to concerns about online pedagogy and policy, we need to understand more from faculty who have crossed some of the first hurdles. Where can one go to look for the early adopters or at least those who are less resistant to incorporating the Web in their teaching? Who are the ones to ask about online teaching practices? While previous research indicates that college instructors too often are not utilizing the most sophisticated technologies and interaction opportunities, nevertheless, faculty members were considered ideal sources for providing information on Web-based teaching policies, experiences, training, and incentives in higher education. In this report, we sampled college instructors who had a history of sharing resources on the Web.

SAMPLING PROCEDURES

Our sampling of instructors employing the Web for teaching and learning purposes comes from two separate sources. First, we selected a random sample of names from The World Lecture Hall. The WLH is an international site first created in 1994 at the University of Texas at Austin to post college syllabi for courses within a variety of academic disciplines. The developers have received national praise and recognition for offering this service.

When beginning to select that sample, however, we noticed the emergence of another resource for faculty and students in higher education. MERLOT was created in 1997 by the California State University Centre for Distributed Learning. It has since expanded to consortia of other institutions and state systems. MERLOT is now a fast growing and free resource intended as an online community of shared knowledge and ideas. In contrast to the WLH, the MERLOT site was originally designed for sharing a wide variety of online learning materials, including assignments, reviews, and member profiles across many academic disciplines within higher education. The capability for peer instructors to review online learning materials was the key feature that distinguished MERLOT from other online resource sharing sites at the time of this study. Even though the WLH and MERLOT members are not representative of all college faculty members, they provide richer online learning backgrounds and experiences than most other available populations. Over 2000 syllabi reflecting more than 80 disciplines and subdisciplines have been posted to the WLH.

Those posting syllabi to the WLH include faculty from religious studies, sociology, theater and dance, accounting, philosophy, marketing, zoology, history, neuroscience, astronomy, nutrition, anthropology, rhetoric, law, and electrical engineering.

At the time of this study, MERLOT contained over 2000 members representing more than 120 different disciplines. Members of MERLOT include faculty from such disciplines as nursing, teacher education, business information systems, geology, arts, computer science, political science, evolution, and theoretical mathematics. The combined sample population, therefore, included a variety of disciplines, degree programmes, and types and sizes of institutions. It also included a wide range of Web expertise.

All these people, however, either had experience posting syllabi online or posting online profiles, critiques, or learning materials. For some in the sample, however, this may have been just a one-time post or brief comment. While the WLH and MERLOT were perhaps the most well known Web sites for resource sharing within higher education at the time of this study, we were not aware of surveys of college faculty representing either or both of these sites. Our random sample during November and early December 2000 included 415 instructors from MERLOT and 286 from the WLH, or a total of 701 instructors from a wide spectrum of disciplines at both sites.1 From e-mail solicitations to this sample, we collected 222 completed surveys; the vast majority were faculty or administrators with additional college teaching responsibilities. While our 32 per cent response rate was generally lower than direct mail or phone surveys, online survey research suggests that this rate is quite good. However, at this time, no expected response rate for online surveys has been firmly established. Nearly fifty different disciplines and subdisciplines were represented in our final sample. Most responses were received from instructors from across the United States, though around 5 per cent of the respondents came from other countries including Hong Kong, Australia, Canada, and the United Kingdom.

LIMITATIONS OF THE STUDY

As with most online surveys, the present project had several limitations that may have constrained the results and generalizability of the study:

- There are few available resources for faculty online course-sharing, thereby limiting the selection to two of the more popular sites, the WLH and MERLOT. These two Web sites were possibly not representative of all college faculty members who use the Web in their teaching.
- Since users created these sites over long periods of time, many of the collected online faculty member names and e-mail addresses were outdated, incorrect, or changed, especially those in the World Lecture Hall.
- Many of the faculty respondents here were Web savvy and could be described as early adopters of Web technology, thereby inflating any optimistic results regarding online learning experiences and felt need for additional online collaborative tools compared to college faculty in general.
- Tools for teaching and learning on the Web are constantly changing. As a result, it is difficult to generalize many of the findings of this survey related to the utility of particular Web-based instructional tools.
- The online survey instrument was relatively lengthy, effectively lowering the response rate and perhaps causing some inaccurate or skipped responses.
- This survey report labels respondents as college or post-secondary instructors, even though a few of the respondents were in administrative positions with only part-time faculty or teaching responsibilities.
- In an effort to keep the survey at a manageable length, the online survey failed to address key issues such as how courseware tools are

funded, the per cent of respondents with tenure, the perceived quality of online certificates or institutes, the forms of online training for instructors, the types of technical support provided for students and faculty working online, how costs are determined for online courses, and perceived learning and motivational factors in online learning. It is hoped that future studies will address such issues.

Despite these limitations, the response rate for this online survey was higher than expected for an e-mail solicited Web survey. In fact, only 7 per cent of those solicited in this particular survey explicitly refused to participate.

MAIN UNITS OF COMPUTER

CENTRAL PROCESSING UNIT

A central processing unit (CPU) or processor is an electronic circuit that can execute computer programmes. This broad definition can easily be applied to many early computers that existed long before the term "CPU" ever came into widespread usage. The term itself and its initialism have been in use in the computer industry at least since the early 1960s (Weik 1961). The form, design and implementation of CPUs have changed dramatically since the earliest examples, but their fundamental operation has remained much the same. Early CPUs were custom-designed as a part of a larger, sometimes one-of-a-kind, computer.

However, this costly method of designing custom CPUs for a particular application has largely given way to the development of mass-produced processors that are made for one or many purposes.

This standardization trend generally began in the era of discrete transistor mainframes and minicomputers and has rapidly accelerated with the popularization of the integrated circuit (IC). The IC has allowed increasingly complex CPUs to be designed and manufactured to tolerances on the order of nanometers. Both the miniaturization and standardization of CPUs have increased the presence of these digital devices in modern life far beyond the limited application of dedicated computing machines. Modern microprocessors appear in everything from automobiles to cell phones to children's toys.

HISTORY OF CPU

Prior to the advent of machines that resemble today's CPUs, computers such as the ENIAC had to be physically rewired in order to perform different tasks. These machines are often referred to as "fixed-programme computers," since they had to be physically reconfigured in order to run a different programme. Since the term "CPU" is generally defined as a software (computer programme) execution device, the earliest devices that could rightly be called CPUs came with the advent of the stored-programme computer.

The idea of a stored-programme computer was already present during ENIAC's design, but was initially omitted so the machine could be finished sooner. On June 30, 1945, before ENIAC was even completed, mathematician John von Neumann distributed the paper entitled "First Draft of a Report on the EDVAC." It outlined the design of a stored-programme computer that would eventually be completed in August 1949 (von Neumann 1945). EDVAC was designed to perform a certain number of instructions (or operations) of various types. These instructions could be combined to create useful programmes for the EDVAC to run. Significantly, the programmes written for EDVAC were stored in high-speed computer memory rather than specified by the physical wiring of the computer. This overcame a severe limitation of ENIAC, which was the large amount of time and effort it took to reconfigure the computer to perform a new task. With von Neumann's design, the programme, or software, that EDVAC ran could be changed simply by changing the contents of the computer's memory.

While von Neumann is most often credited with the design of the stored-programme computer because of his design of EDVAC, others before him such as Konrad Zuse had suggested similar ideas. Additionally, the so-called Harvard architecture of the Harvard Mark I, which was completed before EDVAC, also utilized a stored-programme design using punched paper tape rather than electronic memory. The key difference between the von Neumann and Harvard architectures is that the latter separates the storage and treatment of CPU instructions and data, while the former uses the same memory space for both. Most modern CPUs are primarily von Neumann in design, but elements of the Harvard architecture are commonly seen as well.

Being digital devices, all CPUs deal with discrete states and therefore require some kind of switching elements to differentiate between and change these states. Prior to commercial acceptance of the transistor, electrical relays and vacuum tubes (thermionic valves) were commonly used as switching elements. Although these had distinct speed advantages over earlier, purely mechanical designs, they were unreliable for various reasons.

For example, building direct current sequential logic circuits out of relays requires additional hardware to cope with the problem of contact bounce. While vacuum tubes do not suffer from contact bounce, they must heat up before becoming fully operational and eventually stop functioning altogether. Usually, when a tube failed, the CPU would have to be diagnosed to locate the failing component so it could be replaced. Therefore, early electronic (vacuum tube based) computers were generally faster but less reliable than electromechanical (relay based) computers.

Tube computers like EDVAC tended to average eight hours between failures, whereas relay computers like the (slower, but earlier) Harvard Mark I failed very rarely (Weik 1961:238). In the end, tube based CPUs became dominant because the significant speed advantages afforded generally outweighed the reliability problems. Most of these early synchronous CPUs ran at low clock rates compared to modern microelectronic designs. Clock signal frequencies ranging from 100 kHz to 4 MHz were very common at this time, limited largely by the speed of the switching devices they were built with.

DISCRETE TRANSISTOR AND IC CPUS

The design complexity of CPUs increased as various technologies facilitated building smaller and more reliable electronic devices. The first such improvement came with the advent of the transistor. Transistorized CPUs during the 1950s and 1960s no longer had to be built out of bulky, unreliable, and fragile switching elements like vacuum tubes and electrical relays. With this improvement more complex and reliable CPUs were built onto one or several printed circuit boards containing discrete (individual) components.

During this period, a method of manufacturing many transistors in a compact space gained popularity. The integrated circuit (IC) allowed a large number of transistors to be manufactured on a single semiconductor-based die, or "chip." At first only very basic non-specialized digital circuits such as NOR gates were miniaturized into ICs. CPUs based upon these "building block" ICs are generally referred to as "small-scale integration" (SSI) devices.

SSI ICs, such as the ones used in the Apollo guidance computer, usually contained transistor counts numbering in multiples of ten. To build an entire CPU out of SSI ICs required thousands of individual chips, but still consumed much less space and power than earlier discrete transistor designs. As microelectronic technology advanced, an increasing number of transistors were placed on ICs, thus decreasing the quantity of individual ICs needed for a complete CPU. MSI and LSI (medium- and large-scale integration) ICs increased transistor counts to hundreds, and then thousands. In 1964 IBM introduced its System/360 computer architecture which was used in a series of computers that could run the same programmes with different speed and performance.

This was significant at a time when most electronic computers were incompatible with one another, even those made by the same manufacturer. To facilitate this improvement, IBM utilized the concept of a microprogram (often called "microcode"), which still sees widespread usage in modern CPUs (Amdahl *et al.* 1964). The System/360 architecture was so popular that it dominated the mainframe computer market for the decades and left a legacy that is still continued by similar modern computers like the IBM zSeries. In the same year (1964), Digital Equipment Corporation (DEC) introduced another influential computer aimed at the scientific and research markets, the PDP-8.

DEC would later introduce the extremely popular PDP-11 line that originally was built with SSI ICs but was eventually implemented with LSI components once these became practical. In stark contrast with its SSI and MSI predecessors, the first LSI implementation of the PDP-11 contained a CPU composed of only four LSI integrated circuits (Digital Equipment Corporation 1975).

Transistor-based computers had several distinct advantages over their predecessors. Aside from facilitating increased reliability and lower power consumption, transistors also allowed CPUs to operate at much higher speeds because of the short switching time of a transistor in comparison to a tube or relay. Thanks to both the increased reliability as well as the dramatically increased speed of the switching elements (which were almost exclusively transistors by this time), CPU clock rates in the tens of megahertz were obtained during this period. Additionally while discrete transistor and IC CPUs were in heavy usage, new high-performance designs like SIMD (Single Instruction Multiple Data) vector processors began to appear. These early experimental designs later gave rise to the era of specialized supercomputers like those made by Cray Inc.

MICROPROCESSORS

The introduction of the microprocessor in the 1970s significantly affected the design and implementation of CPUs. Since the introduction of the first microprocessor (the Intel 4004) in 1970 and the first widely used microprocessor (the Intel 8080) in 1974, this class of CPUs has almost completely overtaken all other central processing unit implementation methods. Mainframe and minicomputer manufacturers of the time launched proprietary IC development programmes to upgrade their older computer architectures, and eventually produced instruction set compatible microprocessors that were backward-compatible with their older hardware and software. Combined with the advent and eventual vast success of the now ubiquitous personal computer, the term "CPU" is now applied almost exclusively to microprocessors. Previous generations of CPUs were implemented as discrete components and numerous small integrated circuits (ICs) on one or more circuit boards. Microprocessors, on the other hand, are CPUs manufactured on a very small number of ICs; usually just one. The overall smaller CPU size as a result of being implemented on a single die means faster switching time because of physical factors like decreased gate parasitic capacitance. This has allowed synchronous microprocessors to have clock rates ranging from tens of megahertz to several gigahertz. Additionally, as the ability to construct exceedingly small transistors on an IC has increased, the complexity and number of transistors in a single CPU has increased dramatically. This widely observed trend is described by Moore's law, which has proven to be a fairly accurate predictor of the growth of CPU (and other IC) complexity to date.

While the complexity, size, construction, and general form of CPUs have changed drastically over the past sixty years, it is notable that the basic design and function has not changed much at all. Almost all common CPUs today can be very accurately described as von Neumann stored-programme machines. As the aforementioned Moore's law continues to hold true, concerns have arisen about the limits of integrated circuit transistor technology. Extreme miniaturization of electronic gates is causing the effects of phenomena like electromigration and subthreshold leakage to become much more significant. These newer concerns are among the many factors causing researchers to investigate new methods of computing such as the quantum computer, as well as to expand the usage of parallelism and other methods that extend the usefulness of the classical von Neumann model.

CPU OPERATION

The fundamental operation of most CPUs, regardless of the physical form they take, is to execute a sequence of stored instructions called a programme.

The programme is represented by a series of numbers that are kept in some kind of computer memory. There are four steps that nearly all CPUs use in their operation: fetch, decode, execute, and writeback.

The first step, fetch, involves retrieving an instruction (which is represented by a number or sequence of numbers) from programme memory. The location in programme memory is determined by a programme counter (PC), which stores a number that identifies the current position in the programme. In other words, the programme counter keeps track of the CPU's place in the current programme. After an instruction is fetched, the PC is incremented by the length of the instruction word in terms of memory units. Often the instruction to be fetched must be retrieved from relatively slow memory, causing the CPU to stall while waiting for the instruction to be returned. This issue is largely addressed in modern processors by caches and pipeline architectures.

The instruction that the CPU fetches from memory is used to determine what the CPU is to do. In the decode step, the instruction is broken up into parts that have significance to other portions of the CPU. The way in which the numerical instruction value is interpreted is defined by the CPU's instruction set architecture (ISA). Often, one group of numbers in the instruction, called the opcode, indicates which operation to perform. The remaining parts of the number usually provide information required for that instruction, such as operands for an addition operation. Such operands may be given as a constant value (called an immediate value), or as a place to locate a value: a register or a memory address, as determined by some addressing mode. In older designs the portions of the CPU responsible for instruction decoding were unchangeable hardware devices. However, in more abstract and complicated CPUs and ISAs, a microprogram is often used to assist in translating instructions into various configuration signals for the CPU. This microprogram is sometimes rewritable so that it can be modified to change the way the CPU decodes instructions even after it has been manufactured.

After the fetch and decode steps, the execute step is performed. During this step, various portions of the CPU are connected so they can perform the desired operation. If, for instance, an addition operation was requested, an arithmetic logic unit (ALU) will be connected to a set of inputs and a set of outputs. The inputs provide the numbers to be added, and the outputs will contain the final sum. The ALU contains the circuitry to perform simple arithmetic and logical operations on the inputs (like addition and bitwise operations). If the addition operation produces a result too large for the CPU to handle, an arithmetic overflow flag in a flags register may also be set.

The final step, writeback, simply "writes back" the results of the execute step to some form of memory. Very often the results are written to some internal CPU register for quick access by subsequent instructions. In other cases results may be written to slower, but cheaper and larger, main memory. Some types of instructions manipulate the programme counter rather than directly produce result data. These are generally called "jumps" and facilitate behaviour like loops, conditional programme execution (through the use of a conditional jump), and functions in programmes. Many instructions will also change the state of digits in a "flags" register. These flags can be used to influence how a programme behaves, since they often indicate the outcome of various operations. For example, one type of "compare" instruction considers two values and sets a number in the flags register according to which one is greater. This flag could then be used by a later jump instruction to determine programme flow.

After the execution of the instruction and writeback of the resulting data, the entire process repeats, with the next instruction cycle normally fetching the next-in-sequence instruction because of the incremented value in the programme counter. If the completed instruction was a jump, the programme counter will be modified to contain the address of the instruction that was jumped to, and programme execution continues normally. In more complex CPUs than the one described here, multiple instructions can be fetched, decoded, and executed simultaneously. This section describes what is generally referred to as the "Classic RISC pipeline," which in fact is quite common among the simple CPUs used in many electronic devices (often called microcontroller). It largely ignores the important role of CPU cache, and therefore the access stage of the pipeline.

ROLE OF COMPUTER SCIENCE IN THE PROCESS OF GLOBALIZATION

The global society or globalization is something, which is an accepted reality of the modern age. The development of science and technology especially related to the field of Computer Sciences is responsible to a great extent for accelerating the process of globalization.

A few of such inventions and discoveries related to the subject of Computer Science may be named as below:

- Development of printing material and communication through written verbal material.
- Development of transport system with the discoveries and inventions related to travel on land surface, air, sea and space.
- Development of communication network with the inventions and discoveries like telephone, wireless, telegraph, teleprompter, radio, television, video, camera, photography still and movie pictures, satellite communication, mobile telephony, tele-conferencing, video conferencing, *etc.*
- Development of modern sophisticated communication system with the help of computer technology, internet access facilitating, e-mail and audio-visual transmission through web camera and web sites coupled with audio listening and speaking devices.
- The great invention and discoveries mentioned as above in the field of transport and communication services brought out by Computer Sciences have helped in the process of globalization in the ways narrated as below:

(i) Travelling from one corner of the globe to the other has become too convenient and less time consuming. It has provided needed mobility to the individuals or group as a whole for the interaction with the rest of the world.

(ii) It is quite easy and speedy as well as to transport commodities from one corner of the globe to the other. That is why, it is no wonder to get benefit of the productions of the commodities grown or manufactured in one part of the globe to the other parts in no time with a reduced cost and labour.

(iii) We can be in touch with the individuals, organi-zations and events belonging to the farthest corners of the globe with the help of the much development means and tools of communication. The distance has to barriers at all for any type of communication—audio as well as visual.

The facilities available as above in terms of removing barriers of distances have invariably brought together the individuals, groups and nations of the world in the form of a single knitted unit truly in the spirit of "Basudheve Kutumbkam" *i.e.*, "the whole world is my family". As a result the people of the world have a close interaction, inter-dependence and inter-relationship with each other irrespective of their living and working distances. What happens with an individual, community, region or a country now affects in one way or the other the rest of the world. Poverty of a region is now the concern of the other events and political turmoil. As a result you may find that terrorism has become global, trafficking in drugs or human beings has become global, sexually transmitted and also other types of viral and infectious diseases have become global. One the other hand we now have a tremendous increase in the speed or globalization at the economic as well as socio-cultural exchange fronts. It has resulted in the process of denationalization of market, politics and legal systems for paving the way of the so-called global economy.

The emergence of the phenomenon of global trade and commerce has now provided enormous opportunities for an organization or company belonging to a particular part of the global to establish itself in the foreign market. It is easy for her now to adopt first her product or services to the final users linguistic and cultural requirements and then take advantages of the internet revolution for establishing a virtual presence on the international market place with a multilingual corporate website or even resorting to an electronic business, trade and commerce according to the mutual convenience of the business/trade partners. In this way globalization has resulted in intertwining the fates of the individuals, community and nations of the world and this dream has become true only on account of the services provided by the numerous inventions and discoveries made in the field of Computer Sciences.

GLOBALIZATION AND COMPUTER SCIENCES

The term globalization derived from the words 'globe' and 'signifies' the removal of barriers of distances or of other nature for bringing people of the world together in terms of their relationships of events. For the understanding of its meaning let us think over on a few definitions given below:

1. The sociologist, Anthony Giddens, defines globalization as a decoupling of space and time, emphasizing that with instantaneous communications, knowledge and culture can be shared around the world simultaneously.
2. The Dutch academician Rudd Lubbess defines it as process in which geographical distances become of diminishing importance in the establishment and maintenance of cross economic, political and socio-cultural relations.
3. David Held and Anthony McGrew say that globaliza-tion can be conceived as a process (or set of processes) which embodies a transformation in the spatial organization of social relations and transactions, expressed in trans-continental or inter-regional flows and network of activity, interaction, and power.

These definitions point out the following things about the meaning and nature of the term globalization:

1. Globalization in the result of a rapid and efficient system of communication network. It aims towards the sharing of knowledge and culture among the people and communities of the world.
2. Globalization makes possible nearness between the individual and organization of the world community belonging to different regions, countries or continents in terms of their social relationships, interactions and sharing of comforts and power.

In the light of the above meaning and characteristics, the term globalization may be defined as the process of interlinking the individuals and organizations of the world community economically, politically and socio-culturally by barriers of the space and time.

ATTRACTING WOMEN INTO COMPUTING

The majority of data collected about women in IT has been qualitative analysis such as interviews and case studies. This data has been used to create effective programmes addressing the underrepresentation of women in IT. Suggestions for incorporating more women in IT careers include formal mentoring, ongoing training opportunities, employee referral bonuses, multicultural training for all IT employees, as well as educational programmes targeting women.

The number of female college entrants expressing interest in majoring in computer science worsened in the 2000s to pre-1980's levels. A research study was initialized by Allan Fisher, then Associate Dean for Undergraduate Computer Science Education at Carnegie Mellon University, and Jane Margolis, a social scientist and expert in gender equity in education, into the nature of this problem.

The main issues discovered in interesting and retaining women in computer science were feelings of an experience gap, confidence doubts, interest in curriculum and pedagogy, and peer culture. Universities across North America are changing their computer science programmes to make them more appealing to women. Proactive and positive exposures to early computer experiences, such as The Alice Project, founded by the late Randy Pausch at Carnegie Mellon University, are thought to be effective in terms of retention and creation of enthusiasm for women who may later consider entering the field. Institutions of higher education are also beginning to make changes regarding the process and availability of mentoring to women that are undergraduates in technical fields.

Another strategy for addressing this issue has been early outreach to elementary and high-school girls. Programmes like all-girl computer camps, girls' after-school computer clubs, and support groups for girls have been instilled to create more interest at a younger age. A specific example of this kind of programme is the Canadian Information Processing Society outreach programme, in which a representative is sent to schools in Canada, speaking specifically to grade nine girls about the benefits of Information Technology careers. The purpose is to inform girls about the benefits and opportunities within the field of information technology. Companies like IBM also encourage young women to become interested in engineering, technology and science. IBM offers EX.I.T.E. (Exploring Interests in Technology and Engineering) camps for young women from the ages of 11 to 13.

Additionally, attempts are being made to make the efforts of female computer scientists more visible through events such as the Grace Hopper Celebration of Women conference series which allows women in the field to meet, collaborate and present their work. In the USA, the Association for Women in Computing was founded in Washington, D.C. in 1978. Its purpose is to provide opportunities for the professional growth of women in computing through networking, and through programmes on technical and career-oriented topics. In the United Kingdom, the British Computer Society (BCS) and other organizations have groups which promote the cause of women in computing, such as BCSWomen, founded by Sue Black, and the BCS Women's Forum. In Ontario, Canada, the Gr8 Designs for Gr8 Girls programme was founded to develop grade 8 girls' interest in computer science.

RECENT EFFORTS

In September 2013, Ada Developers Academy, a tuition-free 1 year intensive school in computing for women was launched by Technology Alliance in Seattle, and students could even apply to receive a $1000-per-month-stipend. The first half of the course will focus on HTML/CSS, JavaScript, Ruby on Rails and database fundamentals. The Academy plans to take on new students every 3 months, in a rotating programme.

Having started in the US, Girl Develop It is a network of city chapters that teach women from all parts of the country learn to develop software with HTML and CSS, Javascript, Ruby and Rails, Python, and Android. The organization was co-founded by Sara Chipps and Vanessa Hurst in 2010. As of 2013, it has

17 city chapters running regular courses and events. The programmes offered by Girl Develop It are all taught by volunteers that are employed in the technology field. Structural and content resources used to teach the programmes have been developed and are offered for free both on their website and on GitHub.com.

Hackbright Academy is an intensive women-only 10 week programming course in San Francisco. A Moms in Tech sponsorship for Hackbright Academy is also available for mothers who are former IT professionals and wish to retrain and return to work as a technically-hands-on lead or manager, sponsored by Facebook.

Geek Girl is an organization that was started in March 2006 by Leslie Fishlock. It is an organization that acts as a technology resource for women. The organization strives to empower women of all ages through making technology easy to understand and use. These services are provided entirely by women. Though the target audience tends to be female and the organization was founded on the goal to empower women, men are also encouraged to participate in any of the events or services the organization offers. Geek Girl hosts hosts localized events, meetups, and conferences. The organization also supports a video channel titled GeekGirl TV that provides workshops about technological tools as well as provides coverage for their events for those who are unable to attend. Additionally, Geek Girl's website hosts a blog that provides technology-related news and information that is accessible to a reader with minimal technology experience.

CodeEd is a non-profit organization that focuses on teaching computer science to young girls in underserved communities. The organization partners with schools and programmes to help provide volunteer teachers, computer science course offerings, and computers. The organization was co-founded by Angie Sciavoni and Sep Kamvar in 2010. CodeEd provides courses in HTML and CSS, and provides the curriculum and course material for free under a Creative Commons Attribution license. The organization offers classes that are taught by a team of two volunteer teachers, provide lessons in one hour blocks that may be dispensed in a way that works for the receiving school, and teachers through fun and experimental projects. Code Ed currently offers services in New York City, Boston, and San Francisco.

An organization that facilitates a community driven to inspire women to take on a role in the computer sciences. The organization was founded at Stanford University by now-alumnae Ellora Israni and Ayna Agarwal, who spearheaded the organization's inaugural conference in April 2012. The conference featured female speakers who held tech positions in companies like Google, Pinterest, and Facebook and was well attended.

The conference inspired its organizers to continue with and expand upon she++ and now facilitates participation initiatives through hosting additional events such as a 2013 conference, curating a video library that features inspirational stories from technology professionals, and by offering a mentorship programme. The organization is run by a collection of female students and Stanford University.

Nerd Girls was launched in 2000 by Dr. Karen Panetta, a Professor of Electrical and Computer Engineering at Tufts University. It is an organization that is represented by a group of female engineering students each year and encourages women to take on roles in the engineering and technology profession. The organization celebrates the coincidence of science knowledge and femininity. Participating members solve real-world problems as a group by addressing and fixing technology related issues in the community. Nerd Girls has gained national attention since its launch and has been approached by media producers to create a reality show based off the organization's problem-solving activities. Nerd Girls is sponsored by the Institute of Electrical and Electronics Engineers (IEEE).

Femgineer was started in 2007 by Poornima Vijayashanker. It was originally developed as a blog that focused on engineers, which evolved into an organization that supports women in technology careers. Femgineers is now an education-focused organization that offers workshops, free teaching resources on the topic of technology, supports forums and Meetups, an a team has been developed to continue to expand on the original blog.

Poornima Vijayashanker is an avid public speaker and regularly speaks at technology-related conferences and events about the technology industry and about Femgineer itself. In addition to founding Femgineer, she also founded a startup called BizeeBee in 2010 that supports growing fitness businesses, teaches technology workshops for tech-driven organizations around the country, and was named one of the ten women to watch in tech in 2013 by Inc Magazine.

Numerous higher education institutions have seen development of student-run organizations that focus on the advancement of women in computer science. In addition to she++ based out of Stanford University, Rochester Institute of Technology (RIT) supports a chapter of the organization called Women In Computing. The campus's chapter of the organization is composed of students, faculty and staff at RIT and they strive to support and further develop the culture of computing to women. This effort is not only focused on their campus, but in the larger community. They host events both on their campus located in Henrietta, New York, and within surrounding Rochester schools. RIT is among a national list of schools that host a chapter of Women in Computing, which is founded in the organization Association of Computing Machinery's committee for women in computing (ACM-W). Harvard University hosts the organization titled Harvard Undergraduate Women in Computer Science (WiSC). The organization aims to promote women in computing across a variety of schools and industries, educate women on the profession of computer science, and provide opportunities for women in technical fields. WiCS supports the annual conference named WECode, a conference that aims to promote women's involvement in computer science.

3

Challenges of Multimedia Integration in Contemporary Educational Technology

DEFINITIONS

Multimedia. is a term frequently heard and discussed among educational technologists today. Unless clearly defined, the term can alternately mean.a judicious mix of various mass media such as print, audio and video. or it may mean the development of computer-based hardware and software packages produced on a mass scale and yet allow individualized use and learning. In essence, multimedia merges multiple levels of learning into an educational tool that allows for diversity in curricula presentation.

Multimedia is the exciting combination of computer hardware and software that allows you to integrate video, animation, audio, graphics, and test resources to develop effective presentations on an affordable desktop computer. (Fenrich, 1997)..Multimedia is characterized by the presence of text, pictures, sound, animation and video; some or all of which are organized into some coherent programme. (Phillips, 1997). Today's multimedia is a carefully woven combination of text, graphic art, sound, animation, and video elements. When you allow an end user, *i.e.,* the viewer of a multimedia project, to control 'what' and 'when' and 'how' of the elements that are delivered and presented, it becomes interactive multimedia.

As such multimedia can be defined as an integration of multiple media elements (audio, video, graphics, text, animation, *etc.*) into one synergetic and symbiotic whole that results in more benefits for the end user than any one of the media element can provide individually.

Specific uses of multimedia include:

- Drill and practice to master basic skills
- The development of writing skil
- Problem solving
- Understanding abstract mathematics and science concepts
- Simulation in science and mathematics
- Manipulation of data
- Acquisition of computer skills for general
- Purposes, and for business and vocational training
- Access and communication to understand populations and students
- Access for teachers and students in remote locations
- Individualized and cooperative learning
- Management and administration of classroom activities

CHALLENGES IN EDUCATION

"Learning without Burden", the report of the Yash Pal Committee of 1993, has extensively reported on the ills of the present education system. Briefly, it has shown how the education system has become highly centralized, examination driven, joyless, impersonal, and utterly irrelevant to the child's world.

The centralization deprives teachers of the freedom to organize teaching learning and meaningfully participate in the preparation of syllabi or textbooks. This in itself is bad enough, but now in addition to what is happening in India, it has become necessary to face the challenges of a rapidly changing world in the twenty-first century.

As the world shrinks on account of developments in science and technology, these changes affect Indian society increasingly in many different ways. The world today is a global village, and this represents unprecedented challenges for Indian Education. No society can live in isolation. This reality has a bearing on social processes in both the world as well as in India. This process has been going on for some time, but in the last ten years the pace at which the world is changing is becoming greatly accelerated.

KNOWLEDGE EXPLOSION

A decade ago, the knowledge base of humanity used to double every ten to twelve years; now it doubles every two to three years. Does this mean that there should be an even bigger load of material for children to learn? Or is there a way in which knowledge need not be served in different packages in schools? Is it possible to weave knowledge in a multi-disciplinary fashion into questions that are of relevance and interest to the learners? Can we provide sources for learning that are more open than the traditional ones?

TECHNOLOGICAL EXPLOSION, A DOUBLE-EDGED SWORD

A very important factor impelling change has been the technological explosion, particularly in the area of ICT (Information and Communication

Technologies). Such technologies are double-edged swords. They allow people to contact one another and exchange ideas very easily in order to create communities built around common interests and common causes. They also make it possible for global corporations to move billions of dollars around the world with the click of a button.

This gives them tremendous power over local and national economies, especially of Third World countries like India. Democratically elected national governments of Third World countries, even big ones like India, are no longer as sovereign as they were twenty years ago. With the profit motive reigning supreme, global corporations see human beings as consumers of their products and not as citizens with inalienable civic rights and duties. A byproduct of this phenomenon has been the loss of diversity in the biosphere, in cultural mores, and the ways in which we live. The world is becoming increasingly homogenized.

HOMOGENIZATION OF THE WORLD

The corporate world empire uses the tools of aggressive advertising and marketing campaigns and a centrally controlled media to turn around public opinion to support its agenda by means of what Noam Chomsky calls the "manufacturing of consent". As mass production leading to profits means mass consumption, global corporations like to disinvest the world societies of diversities and pluralities, something that India has always cherished and deeply valued. The more homogenized the communities of the world become, the more effective their media and marketing reach can be.

Multinational giants, therefore, pose a threat to diversities of both the environment and culture. The consumerism they help to promote a life style in which wasteful ways that the Earth cannot support become the needs created by advertising. The scenario of competition leads to aggression and violence, which strip human beings of the essence of humanity, living in cooperation and harmony with others and with their surroundings.

This attack of the global corporate empire needs to be met by teaching young people democratic values and equipping them with a sense of discernment so that they can choose the right way to build a better world. Open sources, which are now increasingly becoming available, can help break corporate monopolies.

There is no end to the thirst of the corporate empire for power and control; it tries to use every means, fair and unfair to extend its reach in various ways. The latest thrust in this direction from the DPEP (District Primary Education Programme) sponsored by the World Bank has now become clear. Education has now fallen under the umbrella of the General Agreement on Trade in Services (GATS). GATS and the World Trade Organisation (WTO), education is a service, a marketable commodity. They have pushed the Indian government to accept this premise, and India is well on its way to participating in the WTO-controlled globalization of education. The only way to preserve our secular democratic values and way of life is to ensure that our people are enabled to become stronger so that they can fight back this menace that will surely destroy the only habitat of life that we know, Earth. Already life has become worse on account of the crisis of potable water and environmental degradation. There are several ways in which people are fighting back all over the world, and also in India. Two presentations made before the Focus Group were electrifying. One was from Pastapur, where multiply disadvantaged women from 70 villages, organized in Sanghams, have linked food security with many social and educational concerns, and have used ET as a weapon to attain equity, preserve human dignity, and achieve development.. The second presentation was about the work being done by a group of engineers from IIT Madras to provide technology that is both cheap and suited to Indian conditions to enable people to access information and better their lot in life.

These new technologies used in the right way can empower ordinary people, and ET can thus become a tool in this struggle that is taking place all around us. The Internet and the Web provide alternative sources of information and connectivity across the world to people who share similar interests and concerns. This could help in creating several power centres in the peripheries that would correct the imbalance of central rule in every sphere, including education. It would then become possible to look at knowledge not as something that comes from a central source, but that emanates from all around us.

POPULATION EXPLOSION

Another important factor behind change is the population explosion. Globally, population has increased several folds, but the strange fact is that while the population in the developed world is declining, it is increasing at a phenomenal rate in the developing world. A special demographic feature in India is that the country has one of the world's youngest populations. Furthermore, in the next decade, it is expected that over half of these young people will be below twenty years of age.

This number itself will pose an unprecedented challenge, and we have nowhere to look for a solution, as no country in the history of the world has ever had to face this problem. Given our track record in bringing children to school, keeping them there, and attempting to provide them with a decent education, conventional solutions will not suffice. It is a major challenge to provide large-scale access to all parts of children, including the 10 per cent or so who are disabled, especially when education must also be equitable and of good quality.

SCARCITY OF RESOURCES

In the absence of assured access to alternative support materials—libraries, teaching aids, audio-visual material—textbooks have come to play a dominant role in the teaching-learning process. Textbooks combined with examinations, which test what has been memorized from textbooks, have exerted a stranglehold over the educational system in India; they have thwarted all attempts at curricular reform and have even undermined the goals of education. How can ET be harnessed to address these problems?

COURSE WEBSITE STRUCTURE

COURSE NOTES

Perhaps the most important and difficult part of developing a web-based course is creating the online content which begins with translating the basic lecture materials to the web and integrating media such as sound, images and even video.

The lecture homepage is divided into:

- *Title*: Lecture number, chapter number, and subject.
- *Lesson*: The main part of the page, which uses multimedia for illustration.
- *Example*: Links for any examples illustrating the lesson (problem statement, given data, required items, solution steps).
- *Pages references*: List of all information resources used to construct the lecture.
- *Assignments*: Link for the lesson assignment and due date.
- Related Links and Extra Readings.
- *Help tools*: Link to calculator, unit converter, and list of tables needed for solving the example.

COMMUNICATION TOOLS

Computer-mediated communication (CMC) is communication accomplished through the use of computer and networking technologies among faculty and students. It can be person-to-person (such as e-mail) or among a group (for example, a 'listserv' or newsgroup). Although the quantity of interaction may not be as great as it is in a standard classroom, users of CMC often find that the quality of the correspondence is better and the rate of learning is higher.

CMC uses include:

- Students use e-mail to ask questions of faculty or teaching assistants at times other than class periods or office hours and even when faculty is away at professional meetings. Answers to frequently asked questions (FAQ) might be posted to a shared location.
- Faculty asks a critical question prior to class so students are better prepared for in-class discussion.
- Students share their papers, outlines, homework problems and project plans to receive feedback from other students.
- Posting important announcements.
- Creating groups and having group discussions on a specific topic.
- Posting lecture notes, sample exam questions, or study tips.
- Requiring discussion questions or homework to be turned in electronically.
- Having an on-line help desk supervised by the professor or teaching assistant.

Computer-mediated communication can be synchronous or asynchronous. Synchronous communication is the exchange of messages among correspondents who are on-line at the same time. One form of synchronous communication is online text-based chat and conferencing. Educational uses include virtual office hours and small group meetings. On the other hand, asynchronous communication is the exchange of messages among correspondents who are not on-line at the same time. The most common forms include e-mail, newsgroups (Usenet), mailing list servers, group project collaboration and course discussion groups.

Whether the type of communication is synchronous or asynchronous, it can be on a whole range of levels. These different levels were implemented in the developed web-based courses.

- *One-alone*: *e.g.,* one person accesses on-line resources such as on-line databases or journals, remotely executes software programmes stored on a remote computer, or downloads application software via Internet File Transfer Protocol (FTP).
- *One-to-one*: *e.g.,* two people send messages back and forth via e-mail such as a student corresponding with a teacher or two students communicating.
- *One-to-many*: *e.g.,* learning materials can be posted to a website by a teacher, forming an electronic lecture which any number of students can view.
- *Many-to-many*: *e.g.,* any number of participants (students or teachers) interacts via chatting, a computer conferencing system. Debates, discussion groups and brainstorming can take place.

The following communication components were implemented in the developed web courses:

- *E-mail*: E-mail between faculty and students can be integrated into the web environment. The web page allows e-mail to be sent to faculty and classmates, and a pop mail system can be integrated for reading e-mail messages. In both cases, e-mail can include attachments of any binary file (*e.g.,* word processing files, spreadsheets, graphic images, and even sound and video files). The mailing services included in the course website were provided from Zap Zone Network. Students can access the mail login page. With this service, an instructor can monitor his or her students, send e-mail to all of them at the same time informing them about any changes in the course, or reminding them of any important dates.
- *Message board/discussion group*: A message board for communication among all course participants is a wonderful resource allowing for course discussions, questions regarding course material and assignments, and course announcements. Its advantages are tremendous including greatly enhanced student inclusion and participation in the course. Another communication facility is the discussion group that sets up a forum for site visitors to communicate with each other. A discussion group allows site visitors to post articles and reply to them. The easiest way to create a discussion group with FrontPage 2000 is by using the Discussion Web Wizard. The wizard asks for the desired features, then creates a web and

sets up the pages for you. After the web is created, you can open the pages and customise them. Another way to create a message board is by using on-line free board services like inside the web service.

- *Real-time chat facility*: Allows for the holding of real-time typed conversations. Office hours can take place this way without the need for instructor, students or teaching assistants (TAs) to travel to campus. A multichat service was used in the course web page. MultiChat is a Java chat client applet service that enables you to place a chat room on your own site.
- *Feedback form*: Provides the instructor with the student's response and comments. The user should first choose the comment kind from the following: Complaint, problem, suggestion, or praise. Then he should use the pull-down menu to select the item he wants to comment about (website, class, lab, instructor, TA, technical help, or other). The last step is to write the comment in the provided field and his contact information.
- *Announcements*: Effective announcements need to be read; for that to happen the students need to know when a new announcement has been posted. Alert boxes or running footers (using JavaScript) or a blinking link added to a page can let students know of new announcements. Such announce-ments are implemented in the web course site to remind students of exam dates, assignments due date, *etc.* Announcements are created with FrontPage 2000 using Marquee option from the Insert menu.
- *Yellow Shared Board*: A tool to assist chatting sessions. It lets the instructor illustrate his or her ideas to students as in the same way as with pen and paper. Meanwhile the student could participate in the illustration. NetWriter, a free shared Yellow Pad on-line service provided by ParaGraph/Vademto, was used in the course website to implement the yellow-shared board. With NetWriter the instructor can reserve the session ahead of time and send e-mails to students to inform them with the session time and number.

COURSE ADMINISTRATIVE TOOLS

ON-LINE SYLLABUS

An on-line course syllabus provides the instructor with a way to change course material easily, and inform the student with a complete and up-to-date picture of the course requirements. The format need not (and probably should not) duplicate the print version. Hypertext links to sample relevant disciplinary websites may be helpful in giving students (and prospective students) a sense of the disciplinary context for the course.

The Syllabus should include the following:

- Course name, number, and prerequisites
- Class time and location

- Instructor
- Instructor contact information
- Teaching assistance
- Teaching assistance contact information
- Course description
- Course objectives
- Required course materials
- Assessment methods course schedule
- Grading
- Late policy.

CLASS SCHEDULE

Class schedule provides students with a clear idea of the course timetable so they know the specific lesson for each given date.

FREQUENTLY ASKED QUESTIONS (FAQS)

A FAQ is a list of commonly asked questions and their answers. Posting FAQs provides ready answers to the student. FAQs also reduce the amount of time spent in answering questions piecemeal.

Some of the items that may be posted are:

- FAQ concerning course content.
- FAQ concerning technical help (computer support, internet, how to use the website).
- FAQ concerning the course in general (registration, important dates, instructor, TA).

STUDENT ACCESS TO GRADES

It is common practice at many universities for teachers to post grades, sorted by student ID, in a common area, *e.g.,* on an office door. It would be easier, faster and more convenient to post the entire list in the course website.

TESTING TOOLS AND OTHER RESOURCES

ON-LINE EXAMS, QUIZZES AND ASSIGNMENTS

Exams, quizzes and assignments can be delivered to the students via the WWW. The student answers are sent privately to the instructor or TA through e-mail and the results are returned privately to the student.

SELF-EVALUATION TESTING

On-line drill and practice or testing can be used to reinforce material even if not used as part of a grade. Reading comprehension questions, for example, in short answer or multiple choice formats can provide students with self-assessment of their level of understanding of the text.

QUESTIONNAIRE

A questionnaire or a survey is a rapid means of collecting opinion on a wide variety of questions. Most educators will be familiar with end-of-term student questionnaires where students will rate the course they have attended. In our project, three kinds of questionnaires were constructed, the first questionnaire aimed to measure student's computer skills to determine what type of training they will need for handling web-based education.

The second and third questionnaires are dealing with website feedback, evaluation and assessment by students and site visitors. To construct questionnaires that are submitted and stored via the web, you can create quizzes which allow users to record the results of an evaluation, or you can use a specific survey creation tool such as Infopoll Designer. FrontPage 2000 provides a simple way to create forms (for quizzes, exams, feedback forms, or questionnaires) with the form wizard utility.

RESOURCES

The instructor provides any information resources that will help students, support their understanding and broaden their knowledge in the course material.

Such resources include:

- Old exams, quizzes and assignments;
- Related links extra readings;
- File and software download;
- University phone directory and civil engineering department staff information;
- Guides to the Internet and its components;
- Glossary containing terms defined for the course and is searchable via prefix string, which are also linked directly from the notes to the glossary, so a student reading the notes can click on a term to access the definition for that term.

HELP TOOLS

Finding information on the web can be challenging with the number of web servers and web pages growing rapidly. A search engine is the solution for this problem: the search engine is a programme that looks for pages relevant to the keywords the user enters into the engine and displays the results as hyperlinks.

You can add a www search engine to your course website very easily using Java scripts and Java applet. In our course website, a Java script search engine was designed allowing the user to search the net using 1 to 12 of the most popular search engines at the same time, and the results of each engine is displayed in a different window.

Calculators and plotting tools are provide the students with some help in understanding and solving problems. They are mainly designed using Java or Java scripts.

THE NEED FOR MAKING MULTIMEDIA COURSEWARE

Why use multimedia at all? Of what use is multimedia in education? The answers to these questions could be sought through an understanding of the capabilities and limitations of the medium.

Besides being a powerful tool for making presentations, multimedia offers unique advantages in the field of education. For instance, text alone simply does not allow students to get a.feel. of any of Shakespeare's plays. In teaching biology, an instructor cannot make a killer whale come alive in a classroom. Multimedia enables us to provide a way by which learners can experience their subject in a vicarious manner. The key to providing this experience is having simultaneous graphic, video and audio, rather than in a sequential manner. The appeal of multimedia learning is best illustrated by the popularity of the video games currently available in the market. These are multimedia programmes combining text, audio, video, and animated graphics in an easy-to-use fashion.

Moreover, under conditions of chronic under-funding, multimedia can provide an enhanced or augmented learning experience at a low cost per unit. It is here that the power of multimedia can be unleashed to provide long-term benefit to all. Multimedia enables learning through exploration, discovery, and experience. Technology does not necessarily drive education. That role belongs to the learning needs of students. With multimedia, the process of learning can become more goal oriented, more participatory, flexible in time and space, unaffected by distances and tailored to individual learning styles, and increase collaboration between teachers and students. Multimedia enables learning to become fun and friendly, without fear of inadequacies or failure.

ADVANTAGES OF MULTIMEDIA

The pedagogical strength of multimedia is that it uses the natural information processing abilities that we already possess as humans. Our eyes and ears, in conjunction with our brain, form a formidable system for transforming meaningless sense data into information.

The old saying that "a picture is worth a thousand words" often understates the case especially with regard to moving images, as our eyes are highly adapted by evolution to detecting and interpreting movement.

For example, a photograph of Ganges in Varanasi, apart from being aesthetically pleasing, can contain a wealth of information relating to the culture, religion, geography, geology, climate, history, and economics of the area. Similarly, a recording of a politician's speech can allow us to discern significant semantic features not obvious in a written transcript.

For the student, one advantage of multimedia courseware over the text-based variety is that the application looks better. If the courseware includes only a few images at least it gives relief from screens of text and stimulates the eye, even if the images have little pedagogical value. More often than not, the inclusion of nontextual media into courseware adds pedagogical value to the application.

For example, a piece of courseware describing a dig at an archeological site would be more valuable to the student, if it included images of the site, such as enhanced aerial images showing features like old field boundaries, or diagrams illustrating where the digging and scanning took place. In this respect, using the text only, even in a creative way, has obvious limitations as compared to the use of both text and pictures.

SCOPE FOR IMPROVEMENT IN SCHOOL EDUCATION BY USING IT: WEB BASED EDUCATION

If Information Technology is used in school education it provides:

FLEXIBILITY, ACCESSIBILITY, AND CONVENIENCE

With a very short period of training the student can access the learning material when their schedule allows. No separate distribution mechanism needed (WBL), can be accessed from any computer anywhere in the world, keeping delivery costs low, this leads to cost saving.

ENHANCED LEARNING

Cognitively, active and context-based ("real world") learning activities, the highly interactive nature of well designed online learning, flexibility to review course material at any time, all improve learners abilities to synthesize and retain information. Many learners also find it easier to ask questions via E-mail because they have the privacy of direct contact with the instructor and avoid the classroom fear of "exposing" ignorance.

EASE AND SPEED OF UPDATE

WBL allows for efficient and quick updates to course material for frequently changing information. The changes are made on the server programme. Everyone worldwide can instantly access the update.

CONSISTENCY OF LEARNING MATERIAL

Each learner gets identical instructions to ensure the consistency and quality of the message by using WBL.

CROSS PLATFORM

WBL can be accessed by web browsing software on any platform Windows, Mac, UNIX, *etc.* All these factors contribute to improve the quality of school education by overcoming factors like social background of students, parents, different standards of teaching and teachers training programmes, all teachers cannot deliver the same message to all learners.

Also by using WBL students can do their self –assessment and management has access to progress reports and assessment data of individual learner.

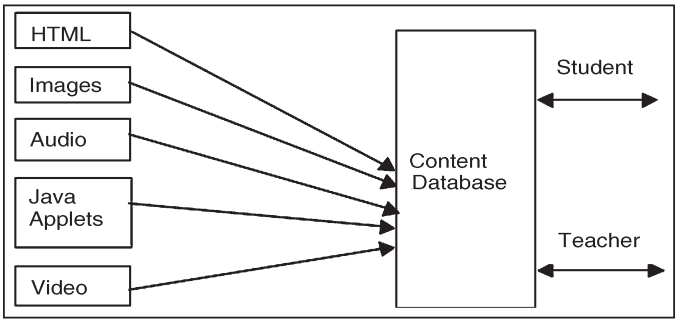
TOOLS OF INFORMATION TECHNOLOGY USEFUL FOR SCHOOL EDUCATION

SYSTEM IMPLEMENTATION STRUCTURE

To implement the WBE we propose the system implementation structure. The school classrooms, office and training centers are connected through Intranet. This Intranet is connected to the Internet by using network operating system. Firewall is introduced between Intranets and Internet in order to provide security.

SYSTEM DESCRIPTION

In initial stage of school education the students are not expert in reading and writing. Subject understanding increases if they learn the things through visualization. With the help of multimedia or Rich Media, which includes, Audio, video, graphics and Java Applets have made WBE very effective. We propose Multimedia content database scheme as shown in fig.



In this database contents the data about educational centers, courses, tutors, students, examinations as well as some story books and games in the form of html pages, audio and video files, Images and Java Applets. Student and teachers can access this database for learning as well as for teaching.

In the primary stage students don't have good knowledge of English. Therefore the presentation should be available in their mother tongue for the better understanding, which is also helpful in improving their pronunciation. This is possible by developing Natural Language Interface to database. One important device called, as "Tech Commander" is also useful for teachers to identify students potential by viewing any students computer display on his own monitor. If he finds something that everyone should see he could set everyone's monitor to display it.

Web Based Education: Considerations and Approaches

- *Conversion of Existing Material*: In order to shift from traditional education to WBE we have to convert the existing school educational material to the Web. The important points to consider are bandwidth, design, usability, and the necessity of high quality media elements and consistency of material across the mediums.

- *Authoring for Multiple Delivery Environments*: We have to provide consistency of interface and ease of authoring and design of an effective multi platform course.
- *Using the Web for student/Teacher Interaction*: Web site can be used for posting of assignments, student work and marks, along with the ability to submit work on-line through the site, also JavaScript and JAVA applets to demonstrate course concepts interactively. This means that course delivery on the Web must be dynamic and truly interactive between the instructor and the students.
- *Faculty Support and Training:* We have to provide centralized support and training resources for training the teachers initially.

Problems to be faced while implementing WBE in school education in Indian context:

Looking at how to use Information Technology in school education, its different tools, the system structure as defined and described it is obvious that we will face some problems while implementing WBE in school education in India.

The major problems we will be facing are:

- Intensive Training to Schoolteachers: Schoolteachers are not introduced to the web based education. Therefore training should be given in order to create a learning environment that will itself train and spur students on the one hand to turn the learning experience into useful, practical and personal knowledge.
- WBL awareness and Workshops: In rural area parents are not much knowing about WBL. So the demonstration, seminars and workshops needs be conducted for society in order to understand the importance of it.
- *Bandwidth Limitations*: Limited bandwidth of Internet connection gives slower performance for sound, video and intensive graphics, causing long waits for downloads that can affect the ease of the learning process. Improved bandwidth will help the teacher to solve his problem.
- *Effect on Teachers*: WBL will lead to reduction in manpower as per as teachers are concerned. This will lead to agitations by teacher's organization.
- *Effect on Students*: Although the students will be benefited by WBL there will some part of students opposing this introduction of technology in education.
- Infrastructure: WBE will primarily require free access to Web to all the learners and hence government of India will have to setup nation wide Fibre Optic Cable network.
- *Access*: Every school will not have equal opportunity to information because of access issues. The schools with fewer budgets will always face this problem. This is the major problem as per as India is concerned, as there is big gap between poor and rich communities in India.

- *Download*: The learning material that appears on web needs to be downloaded will require more time. The speed depends on the transmission methods and bandwidth, which is problem as per as India is concerned.

Important Features of Web-Based Learning Environment

While designing Web-Based Learning sites the following important features should be kept in mind:

- *The Online Syllabus*: An online syllabus provides the instructor with a way to change course material easily and as per the requirements in industry, and the student will have a complete and up-to-date picture of the course requirements. Hypertext links to sample relevant disciplinary web sites may be helpful in giving students (and also prospective students) a sense of the disciplinary context for the course.
- *Personal Home Pages*: Personal home pages can be used to foster the sense that the class is not just a collection of isolated individuals but a community of learners who can profit from interacting with one another. Home pages encourage students to learn about each other so as to encourage contact and mutual interests. This helps the learners to create a group with common interest.
- *Interactivity*: Adding discussion forums and chat sessions to your online course is a common way to add an interactive component to a web-based course. There are many implementations of bulletin board and chat session software to choose from. A second method of interactivity is, of course, e-mail. It's a good practice to have an online list of the e-mail addresses of all registered students, the professor, and teaching assistants. This is possible with an e-mail subscription mechanism included in your Online Syllabus.
- *Assignments*: The web page listings of homework assignments, upcoming events and exams can be more interactive than the familiar print counterparts. If some homework assignments, for example, are based on online materials, they can be directly linked to the class schedule. This helps the students to plan the preparations for the examination in systematic way.
- *Announcements*: To be effective, announcements need to be read; for that to happen, students need to know when a new announcement has been posted. Alert sounds or perhaps a blinking link added to a page can let students know of new announcements, or perhaps, even a mass e-mail to all students in the course. For a home page, or a long life syllabus, various software tools can be used for the subscribers announcement about page changes. All these techniques will attract the learner's attention towards announcements.
- *Testing*: Online drill or practice testing can be used to reinforce material, even if the results are not used as part of a grade. Reading comprehension

questions, for example, in short answer or multiple choice formats can provide students with an assessment of their level of understanding of text. This facilitates the students to measure his level of understanding and through continuous assessment he can try to improve his performance.

- *Course Management*: Software should be available to add or delete students from the course, assign user Ids and passwords, create or edit home pages, and manage any open discussion groups. This helps to keep up to date records of students admitted for various courses.
- *Content*: Perhaps the most difficult part of developing a web-based course is creating the online contents. You can begin by transferring your basic lecture materials to the web and integrating media such as sound, images, and video. Remember, to experiment with incorporating some of the new web-based learning paradigms. And finally, come back and rebuild the lecture building its graph structure and using more html facilities.

Other Features of a Web-Based Learning Environment

- Managing cognitive load — the amount of information people can process — is essential to effective teaching or training. Bombarding learners with too much information at once, called cognitive overload, is one of the chief obstacles to learning. This indicates that we should provide only required information in order to avoid cognitive overload.
- Dividing each tutorial lesson into segments (Classroom, Quiz, Lab, *etc.*) and then further subdividing these segments into a manageable number of chunks allows users to digest new concepts and skills in a manner that prevents overload.
- *Web-based tutorial*: Users will also enjoy a great deal of flexibility in managing their cognitive load, selecting instructional tasks from a menu of lessons, depending upon the amount and kinds of skills they bring with them, and once engaged in a lesson, selecting which portions of that particular lesson they wish to complete. This allows the students to learn the topics in proper sequence and according to his ability of understanding.
- Because the limited capacity of working memory is rapidly overwhelmed by large amounts of new information, frequent opportunities to practice are important. Rehearsal encodes or moves information into long-term memory. The practice assignments can be presented with practice opportunities throughout the classroom portion of the lesson and is also encouraged to complete the practice portion of each lesson. This allows the student to find out how much he has understood at the end of learning a particular module.
- Finally, online testing is used to reinforce material. Elaborative rehearsal involves presenting questions, which allow the user to apply knowledge in an appropriate context, thus encoding it into permanent memory.

- Quiz questions are designed to provide an authentic assessment of user skill levels by calling on the user to apply the appropriate techniques and practices from the lesson.

PRACTICAL DISADVANTAGES OF MULTIMEDIA

Multimedia requires high-end computer systems. Sound, images, animation, and especially video, constitute large amounts of data, which slow down, or may not even fit in a low-end computer. Unlike simple text files created in word processing, multimedia packages require good quality computers.

A major disadvantage of writing multimedia courseware is that it may not be accessible to a large part of its intended users if they do not have access to multimedia-capable machines. For this reason, courseware developers should think very carefully about the type of multimedia elements that need to be incorporated into applications and include only those that have significant value.

Multimedia has other weaknesses too. While proponents of this new technology are very enthusiastic about its potential, they often leave the financial and technical issues unattended. Development costs in multimedia are very high and the process of developing effective multimedia takes time. Time spent on developing the multimedia package requires money so that the true cost of an interactive programme mounts with each delay.

Further, if the prerequisites for using multimedia include access to computers with related software, the user must possess a minimum level of computer literacy in order to exploit the capabilities of this medium for learning. And finally, training of the educator who is unfamiliar with the production and design of multimedia courseware or packages can be equally complicating. The critical question, then, is: How do we overcome some of the identified barriers and begin the process of multimedia implementation alongside the instructor, textbook, and blackboard? It is the barriers rather than the technologies which we must address before multimedia, or for that matter, any media technology becomes as accepted as the printed text or guidebook.

USE OF MULTIMEDIA IN AN EDUCATIONAL SETTING

Let us look at some examples of what is called. Innovative use.. Let us say a student wants to write a paper on desert animals. Traditionally, the primary source for obtaining information would be the encyclopedia generally available in the library. With access to interactive multimedia, the student would collect various textual materials about the camel from sources on a CD-ROM.

In addition, the student may be able to copy a diagram or the skeleton and muscular structure of the camel and the ostrich to study what is common about the two creatures. With a multimedia approach, the student could also access Web sites on the Internet to get more information. The student could then add film clips on these animals in their natural habitat (all may be from the same CD-ROM) and blend them into a report. Then by adding titles and credits, the student now has a new and original way of communicating his/her own individual perspective.

Besides student use, teachers should find multimedia of great use in delivering their lessons. For example, a history teacher could use a multimedia CD to create a lecture on the non-violence movement by using film clippings and audio tapes on Mahatma Gandhi or Martin Luther King, also by incorporating other audio visual information with text to make the subject come alive. All this material would be available on a videodisc.

Similarly, a university professor might use a multimedia CD to prepare or to update information or to teach so as to enliven and also add insight to his/her teaching, thereby improving the quality of the course. The uses of multimedia need not be seen as a tool for classrooms only. In an industry dealing with hazardous materials, workers need to be trained. It could be risky to provide hands on training. In this case, simulated learning can take the place of actual hands on training by using all the features of interactive multimedia. Training can thus take place individually at the learner's pace and on his/her own time.

Medical procedures, first-aid training and instruction of paramedics or even surgeons are made both simple and interesting through the use of multimedia. The doctor or paramedic can run through a complete procedure on videodisc and analyse all the possible outcomes and can evaluate the possibilities before treatment of the real life patient starts.

In all the instances, the user can and normally does work individually and in an interactive mode with the medium.

MULTIMEDIA WEB-BASED TEXTBOOK–OVERVIEW

Recent advances in computing technology have provided convenient and powerful tools for the interaction and visualization of information from large data sources. Through an appropriate CD-ROM or web-based technology it has been possible to provide a rich environment for the retrieval, visualization, interpretation, and querying of the knowledge base that comprises any technological discipline. Course instructors and students can use the system at home, in the office, and in the classroom/laboratory. Access is made available on instructor's and student's personal computers, and in the computer laboratory.

Such a facility provides a much richer tool for instruction and reference than conventional textbooks and traditional classroom presentational media.

Key features of the facility are as follows:

- Presentation of animated diagrams and charts, audio, and video information, with related information viewed in concurrent windows.
- Interaction between the user and the knowledge base–a user could control and direct the sequence of presentation of information, as well as ask questions.

- Guided walkthroughs of user-selected topics, acting as a Virtual Tutor that takes the user through subject matter in a structured manner, but also answering questions and anticipating user questions and misunderstandings. The walkthrough may be formatted as a lecture, case study, or a tutorial session for solving any problem from a set of in-built examples. The user could progress at whatever pace desired, backtrack, and make lateral explorations of the knowledge base.
- Random walkabouts exploring the knowledge base. This is analogous to flicking through the pages of a textbook but is supported by sophisticated query/keyword search and cross-reference tools, as well as backtracking capabilities.
- Interfacing to the Internet with distance learning and conferencing capabilities, allowing the establishment of a virtual classroom in which students and instructors can interact from remote locations, submit class assignments, and return graded material. Also, interfacing with the Internet allows direct reference to external supplementary sources of information through the World Wide Web, as well as greatly facilitates the education of people with physical disabilities.
- A choice between in-depth, intermediate, and abridged presentations of information.
- Assisted exam/test/assignment compilation for instructors, using pre-written questions a la carte, with automated production of model answers.
- Assisted course and lecture compilation for instructors, with preassembled a la carte course structures and lectures.
- Report generation facilities to enable a student to compile and output reports for class assignments, *etc.*, calling on information generated during a session with the system.
- Automated note taking, whereby the user could search information and demonstrations provided in the system, and collate the points of interest into a notebook for future reference or hardcopy output.
- Student self-examination through interactive tests/examinations.
- Simulation facilities allowing users to monitor and control the behaviour of various processes operating under different conditions.
- Gaming facilities operating in single and multiple-user environments. This allows users to interact with each other within simulated environments, and could be used as the basis for class exercises and/or class assignments.

Although virtual reality tools have computational demands beyond the capabilities of most current personal computers, the proposed system is structured to permit future inclusion of this technology. Virtual reality techniques would greatly enhance the simulation and gaming components of the system, enabling, for example, walkthroughs of buildings at various stages of construction.

IMPLEMENTATION AND EVALUATION

SOFTWARE REQUIREMENTS

A plan was developed that would outline the technology requirements for the web-based course system. Technological resources are chosen to fit the curriculum, not vice-versa. The identified requirements of the web-course determine the type of media to be included in the web system. As for determining the software requirements, certain issues were considered including: web-course objectives, training's cost and ease, and total development and maintenance cost.

The software requirements might include:

- Website development (*e.g.,* MS FrontPage),
- Graphics (*e.g.,* Adobe PhotoShop),
- Animation (*e.g.,* Animator Shop),
- Questionnaire and test design (*e.g.,* Infopoll Designer),
- Video (*e.g.,* Platypus Animator), and
- Optical character recognition (*e.g.,* Omini Page).

Table lists the software that was selected in developing the multimedia web-based course.

Table. Software Requirements.

Website development	Microsoft FrontPage2000
Graphics	Adobe PhotoShop, Macromedia Fireworks, MS image composer
Animation	Animation Shop, Microsoft Gif Animator
Questionnaire and test design	Infopoll Designer
Video	Platypus Animator
Optical character recognition (OCR)	Omni Page

DESIGNING MULTIMEDIA WEB-BASED COURSE

The design and development of a website for any course should include all necessary educational materials that the instructor intends to give to the students as well as those materials that the students should retrieve on their own from the library or external references. Having access to such materials on-line is not only a matter of convenience to students but also a matter of saving much of their effort and time. Such a web-based course provides an on-line interactive environment for students to obtain homework assignments and submit their solutions and for professors to grade homework and send results along with feedback to students. Several on-line course components and tools are considered in designing the course home page. The course website structure is demonstrated in Table, and is described in detail later.

Course Lectures: 	• Text. • Animation. • Still pictures and graphs. • Audio. • Video.
Communication Tools: 	• E-mail. • Message board\discussion (news) groups. • Chat room. • Comment and feedback forms. • Announcements.
Administrative Tools: 	• Course and lab syllabus. • Class and lab schedules. • Faculty information. • FAQ. • Exam scores.
Testing Tools: 	• Quizzes and Tests on-line • Student Self-evaluation test, • Questionnaires. • Assignments.
References: 	• Previous exzms and Assignments. • University phone Directory. • Extra Reading. • Course Glossary. • Useful Links. • Files and Software Downloads.
Helping Tools: 	• Search the Course Homepage. • Search the WWW. • Calculators. • Plotting Tools. • Class Mail List.

TESTING, OPERATION AND ASSESSMENT

The end product is then tested for technical functionality on the website and simplicity of use to students. Whenever the system failed to carry out any of its functions, it was taken back to the design stage for further technical reviews and modifications.

The web-based course is incorporated into the teaching process and it has been evaluated by both teachers and students. Learner performance is assessed through quantitative indicators such as: grade scores (of exams, homework, projects) and time of student engagement with the web-based course materials. Qualitative assessment is also carried out through a questionnaire on the website use in the learning process to students and teachers at the end of the course work. This qualitative assessment is also part of evaluating the learning environment for future improvements. Quantitative and qualitative indicators of students in the study programme are then compared to similar indicators of students who did not take part in the programme. Conclusions and recommendations are drawn based on the completion of the evaluation process.

Another type of evaluation is associated with web authoring and design. Considering the enormous amount of information available on-line, web users need some criteria to evaluate the reliability of web information. In this stage, this kind of evaluation can be considered as designing criteria in website authoring.

Website evaluation criteria:

- Content:
  - *Accuracy*:
    a. The information source should be accurate and reliable (compare with other sources, logical information, check author background information).
  - *Authority*:
    a. The name of the individual or group creating the site should be clearly stated.
    b. The creator should give a source for information in the site where necessary.
    c. The website author or manager should provide a way for users to make comments or ask questions.
    d. The website author or manager should be responsive to any questions regarding copyright, trademark, or ownership of all material on the site. Sites that knowingly violate copyright statutes or other laws should not be linked, listed, or recommended.
  - *Up-to-date*:
    a. The information should be updated when needed.
    b. Dates of last up-date should be stated.
    c. Links should be updated when needed.
  - Interaction and student engagement:
    a. The content should encourage students to think and interact.
    b. Evaluation ways for student's knowledge acquisition should be provided (on-line testing, self-evaluation testing, drill exercises).
    c. Ways for students collaboration should be facilitated (shared projects and assignments, student's communication tools).
    d. Students should be encouraged to continue research by providing additional hyper links. Provide communication channels with Experts.
  - Nature of the content
    - There should be enough information to make visiting the site worthwhile.
    - Content should be appropriate for student level and background.
    - Content should be unique (information and images from more than one source, adding animation, sound, links, or any other web features).

- *Quality of writing*:
    a. Well-written text.
    b. The title of a site should be appropriate to its purpose.
    c. Site content should be easy to read and understand by the intended audience.
    d. Spelling and grammar always should be correct.
- *References*:
    a. Appropriate references and copyright statement should be included when needed.

• Navigation:
- Links:
    a. Moving around the website should be easy.
    b. Sufficient shortcut or hot buttons should be provided.
    c. Links should be clearly and accurately described.
    d. Navigation links should be visually obvious.
    e. Links are logically grouped.
- *Site organization*:
    a. Homepage should contain a well-labeled table of content.
    b. Site map should be provided.
- *Consistency*:
    a. Navigation buttons should be consistent throughout the website.
    b. The type styles and background make the page clear and readable.
    c. The layout is consistent from page to page.
- *Ease of browsing*:
    a. You can tell from the first page how the site is organized and what options are available.
    b. There is a link back to the home page on each supporting page.
    c. The links are relevant to the subject.
    d. The icons clearly represent what is intended.

• *Workability*:
- *User Friendly*:
    a. Easy to use web interface.
    b. Help information should be provided when needed.
- *Required computing environment*:
    a. Best-view web browser software should be stated.
    b. Required ‘plug-ins’ or other helper applications should be clearly identified.
    c. Links to web browser and plug-in download sites should be provided.
    d. Text only versions should be provided.
    e. Printer friendly version should be provided.

f. Easy to switch between (Frame- Non-frame) versions if needed.
g. In case of file transfer (file name, type, size, and required time to download should be provided).

- *Searching*:
  a. Website search engine should be included.
  b. WWW search engines should be included to assist further research.
  c. Search engine interface should be intuitive and easy to use.

• *Website Design*:

- *Visual appeal*:
  a. The site design and style enhance information delivery.
  b. The site design should be appealing to its intended audience.
- *Thematic design*:
  a. The design should be related to the site topic.
  b. The design should be consistent for each web page within the website.
- *Clarity of presentation*:
  a. Add appealing web design features like tables and graphs.
  b. Pages should be uncluttered and cleanly designed.
- *Flexibility*:
  a. Website should be viewed and tested by different text browsers (Lynx) and graphics browsers (Netscape Navigator and MS-Explorer).
- *Stimulation*:
  a. The web design layout should get the students' attention and maintain their attention.
- *Appropriateness*:

a. Make appropriate use of graphics in the design layout.
b. The site's design should be appropriate for the intended audience.

• *Performance*:

- *Page acquisition time*:
  a. Try to minimize the time needed to load web pages with the type of connection you are using in your classroom.
  b. Offer a text-only option.
  c. Offer a thumbnail version of large graphics.
- *Connectivity*:
  a. Check the site accessibility (Is the site usually accessible or is it difficult to connect into?).
  b. You can connect quickly to the page.
  c. Site URL should be short and easy to memorize.
  d. The page is available through search engines.
- *Hardware speed*:
  a. Consider your connection speed when you access a website.

- *Multimedia Issues*:
  - *Problems of size*:
    a. Compress large multimedia files to minimize downloading time.
    b. Provide download information (file name, type, size, and required time to download).
    d. Multimedia files such as videos, sounds, and animations are usually very large files and can take a very long time to download. It is recommended to download these types of files ahead of time and have students access them locally from a hard drive or mass-storage device.
  - *Required applications*:
    a. Many multimedia objects on the WWW require a helper application or plug-in. Some helper applications such as Shockwave require an excessive amount of memory and time to load and run multimedia animation. Make sure you have the appropriate helper application or plug-in loaded ahead of time before using these files with students.
  - *Purpose of the multimedia:*
    a. Sounds, graphics or video enhance the site's message.
- *Communication Issues*:
  - *General:*
    a. Provide communication channels with instructor (e-mail, chat room, discussion groups, *etc.*).
    b. Provide communication channels with students (e-mail list for all students in the class).
    c. Provide communication channels with experts (e-mail, invite to chat room, specialized news groups, *etc.*).
    d. Encourage collaborative projects and assignments (provide chat room, e-mail, discussion groups, *etc.*).
    e. Provide feedback and comments forms.
    f. Use announcements to get students attention to important dates and issues.
    g. Provide help and supporting material to enhance student performance (*e.g.,* how to use e-mail, chat room).
- *Objective and Scope*:
  - *General*:
    a. State the purpose of the website.
    b. State kind of intended users.
    c. Specify the scope of the site.

In this project, the evaluation process is still in progress. Initial evaluation results of 35 students are encouraging indicating that more than 88% of the students responded with agree or strongly agree to the general evaluation questions, *i.e.,* the website is very helpful to the course instruction, and the concept of WBI (webbased instruction) is a very effective instruction tool. Students reported convenience of accessing all course materials anytime and anywhere. Extra time and effort were devoted at the beginning of the semester getting acquainted with such a new environment of teaching for the first time compared to other traditionally taught courses. Once getting used to the web-based application, the students appreciate the time saving and the excitement of receiving educational and practical knowledge in a variety of multimedia tools at their finger tips. Currently, we are conducting further improvement and expansion of the course website mainly to make it more interesting, attractive and useful to the students.

For example:

- Animation and visualization of construction operations demonstrating the safe movement of construction equipment and labour on site;
- Alternative efficient site layout options for a given project;
- Simulation programmes of earthmoving operations;
- Walkthrough programmes for site inspection and final testing;
- Increasing the number of self-evaluation quizzes and assignments;
- Expanding the knowledge base of the course material and enhancing the user interface allowing faster information access.

4

Implementation Principles in Educational Technology

These principles are organized into two dimensions: classroom and school-wide. The classroom principles expand upon the premise that effective technology integration requires the time and attention of teachers in the role of instructional designers.

Educational technology does not possess inherent instructional value: a teacher designs into the instruction any value that technology adds to the teaching and learning processes. Thus, the three classroom e-TIPS prompt a teacher-designer to consider what they are teaching, what added value the technology might bring to the learning environment, and how technology can help to assess student learning.

Together these three principles guide a teacher-designer through the important phases of e-signing instruction and also in considering technology as a part of that learning environment. The three school-wide principles focus on technology support features that are present in high quality technology support programmes, the presence of which are correlated to teachers' increased uses of educational technology.

These principles describe the implementation environment necessary to support teachers. Together they will help teachers to evaluate the level of access and support available to them in their integration work, which may help to determine whether or not, given their amount of planning time, a particular integration goal is realistic.

CLASSROOM LEVEL PRINCIPLES

Learning Outcomes Drive the Selection of Technology.

In order for learning outcomes to drive the selection of technology, teachers must first be clear about their lesson or unit's student learning outcomes. This is an important first step in determining whether or not the educational technology available can be a support to teaching and learning. It will allow teachers to be more efficient as they search for available, appropriate technologies because they will quickly eliminate those that do not support their learning outcomes. The learning outcomes teachers might plan for their students might focus on acquisition of facts or higher level thinking in a specific curricular area, more general procedural skills, specific technical skills, or some combination of these.

While educational technology can support any of these types of outcomes, some educational technologies may be more appropriate for certain outcomes than for others. For the technology under consideration for use, teachers must also consider the cognitive demands it places on the user. Does it require them to recall facts, like in drill and practice software? Does it require the user to provide content information and represent their understanding, as tool software (such as a database) does? Or does it require the user to represent their knowledge in a symbolic form, as with a programmable calculator?

Any one of these technologies requires the user to respond in different ways, thereby supporting very different learner outcomes but perhaps also adding to a learner's outcomes. When learning outcomes drive the selection of technology in a classroom, the educational technology will be a better fit for teaching and learning, supporting the achievement of the designated outcomes. The conditions for effective technology integration are enhanced further when teachers across a school all work together to enact this principle: Technology use is linked to larger goals and outcomes at the grade level, department, school, district, or state level. Processes for selecting and purchasing technology are linked to these curricular goals. A variety of educational technology, *i.e.,* software titles, web sites, and peripherals, are present, correlated to grade levels, and characterized by the type of outcomes they support.

Technology use Provides Added Value to Teaching and Learning

The phrase "added value" is used to designate that the particular packaging, delivery method or combination of services in a product brings extra benefits than one would otherwise receive. Here, I use the phrase to communicate that the use of technology brings added value to the teaching or learning processes when it makes possible something that otherwise would be impossible or less viable to do. For teaching, adding value might mean individualizing instruction or making it more responsive to student's questions and interests, or providing additional resources of information so instruction is more real world, authentic, and current.

Educational technology can also aid teachers in providing “scaffolds” that support learners as they move from what they already know and can do to what they are learning for example, by aiding the visualization of or quick reference to information. Educational technology can also help teachers to create social arrangements that support collaborative as well as independent learning by facilitating communication and interaction patterns. This might aid students in carrying out reflection or deliberation themselves, or with others.

Teachers can also use educational technology to support additional opportunities for learners to practice, get feedback, or allow for revision or reflection. Thus, it supports knowledge acquisition and practice, so learners become more fluent in their knowledge. Added value for learning might mean educational technology that supports the accessing of data, processing of information, or communicating of knowledge by making these processes more feasible Educational technology can aid students’ accessing information or representing it in new ways. It can increase access to people, perspectives, or resources and to more current information. Many times, software’s interface design allows learner interaction or presents information in a multi-sensory format. Hyperlinks can allow learners to easily connect to related information. Built-in indexes and key word searching support learners by easing their search through a large amount of information to find what is relevant.

These features all add value by increasing access to data or the users’ control during that access. In terms of processing information, added value might mean that the educational technology supports students learning-by-doing or aids them in constructing mental models, or making meaning, by scaffolding their thinking. For example, a database can allow students to compare, contrast, and categorize information through query features. By asking students to create products with tool software, it requires them to think more deeply about the material in order to represent it with that tool.

For example, to create a concept map students would have to analyse, and then categorize information synthesizing from multiple sources. The resulting concept map would show what they understood to be key and subordinate ideas. When students designed the layout of a hypermedia, multimedia document; this representation would have required them to think about the best media to represent the content on their topic and then analyse and synthesize this information. When word processing text, students can represent their analysis and categorization of information through its formatting and positioning.

For example, by using multiple levels of headings, tables, or other visual clues to visually represent main and subordinate ideas. Educational technology can also add value to students’ ability to show and articulate to others about what they have learned. For example, the World Wide Web is a medium through which it is relatively easy for students to communicate with others around the world. Whether to their peers or outside experts, with educational technology students are able to create more authentic and professional communication, and in the style and format appropriate for the topic. Using educational technology in a classroom to add value to teaching and learning, by adding, extending, or changing what teachers or students do, inherently increases the effectiveness of technology. When teachers work together on this principle in a department, grade level, or school it will ensure that students will learn to use technology to help them find information, organize or analyse it, and then tell others about what they've learned.

Software and hardware being considered for purchase would be evaluated according to the value that it adds to teaching and learning, ensuring that only the most effective materials are selected for purchase. Technology assists in the assessment of the learning outcomes. Planning for the assessment of students' learning outcomes is a key component of designing instruction. At times, teachers will want to collect and return to students formative data, to let them know about their learning progress. Almost always, teachers will want to collect summative information about students' achievement of the learning outcomes. Technology can assist teachers in collecting both formative and summative data that will help them understand how students are meeting or have met the learning outcomes for that lesson or unit.

Some software or hardware actually collects formative data during its use, and some technologies also provide help in the analysis of the information. Generally, these are software programmes designed to assess student learning, such as tutorial or drill and practice software. Some of these programmes, through screens or printouts of information, or other feedback mechanisms, support student's self-assessment of their learning. When students are working on learning procedural knowledge, they need opportunities to practice and develop their skills.

Their progress as they work towards a product can easily be captured through software features such as tracking changes, or by asking students to use the "Save As" feature to freeze earlier versions of their work. These in-process products could help teachers to provide feedback to students for their revision and reflection, thereby aiding teachers' formative assessment practices. In addition, educational technology is an aid to summative assessment, especially performance assessments where students are to produce products that allow them to show what they know and can do.

Products students produce through software, whether a database, "mind map," multimedia or word-processed report, or a Web site, demonstrate what they have learned about both the content of their product, the procedural knowledge required to produce it, and their ability to communicate. The capabilities a product might demonstrate include the skills of editing, analysis, group collaboration, or the operation of the software itself. When teachers use educational technology to assist them in the assessment of students' progress towards or obtainment of learning outcomes it makes technology an even more effective instructional tool.

It will help students to prepare for their future to be asked to create computer-produced products, become accustomed to showing their progress through such products, and describing how these products demonstrate what they know. If this principle were employed consistently within a grade level, department, or a school, teachers would become more skillful at determining what can be learned about students' process skills, his or her progress, and learning through their technology products.

SCHOOL LEVEL PRINCIPLES

I now turn to the principles of technology implementation that are associated with the overall school technology environment, which is shared by all the teachers at the same school. While this means that these principles are usually beyond the control of any one teacher, as a group the teachers at a school can, and do, influence the decisions and priority-setting that would put these principles into place. These school level principles are conclusions from the findings of Dexter, Anderson and Ronnkvist (in press), who describe the quality technology support conditions that are associated with increased teacher and classroom uses of technology. Ronnkvist, Dexter, and Anderson (2000),report that technology support encompasses both technical and instructional domains. In both of these domains, teachers need facilities, staff support, incentives, and opportunities to provide feedback In the school-level educational technology implementation principles we have simplified and collapsed these domains and resource types to the following three e-TIPs.

Ready access to supported technology is provided. Teachers must have convenient and flexible access to and technical support for appropriate educational technology in order for them to utilize it in their classrooms. Perhaps of all the principles, this one is the most self-evident. Without available and working educational technology, it can hardly be utilized in a classroom. But, the two key words in this principle are ready and supported. Ready access means the technology should be close to where teachers need to use it and that it is scheduled flexibly, so that teachers have an opportunity to sign up for it when it is relevant for classroom work.

Here, support specifically refers to the technical domain, like troubleshooting help and scheduled maintenance. The idea of ready access should raise for the teacher questions about whether or not the students could be grouped together to work with the educational technology, if it could be a station through which students rotated, or if all students need to have simultaneous access to the educational technology. Ultimately, the access has to be practical. It must be ready enough that working through the logistics of providing students access to the technology does not outweigh the added value it provides.

Dockterman (1991) describes several possibilities for how to effectively use one computer in a classroom. The instructional uses he describes include using the computer as a presentation tool, as a discussion generator, and as a station to which cooperative groups circulate. Other sources for one-computer classroom ideas are found in most educational technology magazines for practitioners. Means, Olson, and Singh (1995) describe the advantages and disadvantages of a variety of computer placement configurations: Computer labs usually provide enough machines for one student to one computer access. However, scheduling their use and having to move to the lab's location can hamper the integration of the computer with the content under study. Where labs are staffed, scheduling and support of its users contributes to a positive experience; however, this can be a negative experience if relying on the lab staff results in less engagement by the teacher. An advantage of equipment distributed throughout regular classrooms is that it gets the equipment to the where the teachers and students do their work. But because of budget constraints, it might be difficult for the school to provide enough equipment to make student groups feasible in size, or to use them as stations through which students would rotate. More mobile computers, such as laptops or desktop computers on carts can aid in bringing a critical mass of computers to the classroom. However, it does require scheduling and coordination of equipment between staff members. Additional time must be allowed to move and set-up the equipment.

The other key idea in this principle is that there is technical support. Many teachers are able to provide simple troubleshooting on their own. Those who cannot, or when the problem is more complex, must have access to technical support. Most schools have some level of technical support available, although the frequency and level of expertise varies widely. Teachers must individually assess whether or not the level of support available to them serves as an adequate safety net. For example, if technical support is through a staff member who comes to the school only once a week, a teacher would have to determine if s/he could wait that long to continue the activity should a problem arise that s/he could not fix. Of course, no matter what the level of access, a back-up plan is essential for all technology-integrated activities. Ready and supported access at a school obviously adds to the effectiveness of technology, making possible teachers' basic, working access to technology. When a school makes it a priority to provide ready, supported access, the distribution of hardware and software resources is based on instructional priorities; if instructional priorities change, the hardware and software resource distribution is re-visited. For example, computer labs might be dismantled if teachers decide they would benefit from classroom-based access to computers. Schools that work towards this principle also provide trained, reliable technical support at the most frequent level of access it can afford.

Professional Development is Targeted at Successful Technology Integration

Technology professional development is key to teachers' learning to integrate technology effectively into the classroom. The learning needs can be thought of as, one, about learning to operate the software and, two, about learning to use software as an integrated, instructional tool. Too often, teachers' learning opportunities are limited to the operation of the software. Teachers must have frequent opportunities to simply learn how to operate the educational technology but also have learning opportunities that address more than these basic skills.. Possible formats for learning include access to shared resources, training modules, mentoring, face-to-face classes, or online, asynchronous professional development courses or net-seminars.

Whatever the format, the target of professional development for technology must be an opportunity for classroom teachers to examine their goals of instruction and related educational technology resources so they may construct an understanding of educational technology as an instructional tool. Specifically, these extended learning opportunities should guide teachers in the instructional design we have laid out in the three classroom educational technology integration principles. By having sufficient time to explore educational technology and have their technological imagination sparked by examples of it in use, teachers can identify which materials match their learning outcomes (eTIP #1). Professional development sessions should also provide frameworks or criteria that can aid a teacher in determining whether or not an educational technology resource brings any added value to teaching or learning. Likewise, through examples and discussion teachers should have opportunity to consider how might educational technology aid the formative or summative assessment of students' learning. Professional development targeted at successful technology integration at a school increases the effectiveness of technology by ensuring that teachers' learning needs are met with both "how to operate" and "how to integrate" sessions. Because technology integration should be in support of specific outcomes and add value to and assist in the assessment of those outcomes, the professional development sessions would ideally be specific for grade levels and customised to match the outcomes they teach. This means that overall, curriculum connections should often be the central focus of technology professional development sessions and facilitate sharing or instructional planning time.

Teachers Reflect on, Discuss, and Provide Feedback about the Role of and Support for Educational Technology

This principle describes a professional collaborative environment for integrating and implementing technology. In such an environment technology use would be more effective because the school organization would recognize the contribution individual make to the collective knowledge of the school. And the entire staff would work towards consensus about the school's performance, in this case with technology, and how they could improve it.

A collaborative professional community would serve as the vehicle for school-wide knowledge processing about technology integration and implementation, increasing the likelihood of reflective dialogue, sharing of instructional practices, and generally increasing collaboration on new practices. When a school staff has habits of discussing the ways technology is used and supported, they will identify ways to make the technology environment at the school more conducive to effective use. Such collaboration might come from a number of sources; for example, if teachers from all grade levels or subjects were represented on a school's technology committee. When school leaders systematically seek input from teachers and these ideas are used to guide future goals for and decisions about educational technology, this feedback can assist in planning for future educational technology purchases and be used to improve the quality of technology support. When technology integration is regularly discussed among colleagues, they are likely to develop shared goals for technology use. When teachers are asked to reflect on the role of technology in their classroom, it is likely that they will recognize ways to become more effective integrators. Teachers can self-assess their use against shared school-wide goals, as well as set personal goals for their technology uses. When technology integration is underway at a school where teachers' interactions are characterized by professional collaboration, it increases the likelihood of all the other eTIPs being in place, and thus the effective use of technology.

In a collaborative environment teachers share their successes, or failures, at matching technology to outcomes. They can talk about their hopes, or fears, for whether technology will add value to their classroom, and what was revealed, or obscured, about student performance. A school that works to learn from all its members uses input from technology novices and experts alike to create high quality technology support.

CURRICULUM MODELS AND TECHNOLOGICAL RESOURCES

Kennedy states that, "…curriculum developers must reflect on actual practice to understand (appropriate) curriculum development practice". There is a debate about the cost/value relationship of technology implementation in secondary education.

While much technology may provide long-term advantages in educational budgeting, provided resources are allocated towards efficient collaboration, this is, however, dependent on a curriculum focus which identifies the need for collaboration and supports its' implementation.

A cost factor is obsolescence which is an important consideration in technologically related curriculum especially, due both to the cost factor of hardware, software and support. The power of change that technology supports means that the contexts applied to developing technological (and 'information') literacy become ever more important.

Whatever choices are made, it is important to give serious consideration to the factor of rapid obsolescence, and design learning units that interpret curricula appropriately and are sensitive to the constantly changing nature of technology and consequent literacy demands. In response to this, educators can and should build courses that interpret curricula using tools and modalities that are as far as possible 'future proof', while still having sensitivity to current social context.

If this shift in curriculum focus is achieved, then technology can become a 'virtual' benefactor, providing the means to access greater resources than could otherwise be afforded, by virtue of the fact that resources so obtained can be broadly shared. A wide-band networked infrastructure with access to appropriate software tools allows students, classes, and teachers to access and produce online materials, do extensive collaborative work, and share instructional resources. The Internet, for example, provides online information and is a medium by which students and schools can communicate and collaborate, opening opportunities for broad consultation. In this way, Information Technology infrastructures can impact on conventional instruction processes by expanding learning resources beyond individual teacher and school materials, providing lower cost sourcing of information and expertise, and providing communication links for isolated students.

- These advantages are only accessible however, if curriculum models facilitate their implementation, if the funding levels match the rhetoric, and if expenditure decisions are appropriate. Decisions which are not collaborative risk degeneration of the process of effective implementation of technological facilities and can cause overall degeneration in educational resources. Very few areas are more expensive than technological infrastructure. Education Queensland's' collaboration with educators, in providing funding assistance develop appropriate electronic resources, illustrated in the Education Queensland Curriculum Resource Exchange is laudable, and demonstrates in its details the power and strength of collaborative and supported electronic information development processes. However assessment of current efforts in regards to collaborative decision making show mixed results.
- This is important consideration, as the cost of technology is frequently raised by advocates of barriers to incorporating technology into the educational environment. Blocks to the implementation of a strong technological infrastructure, associated with an appropriate curriculum, are largely psychosocial rather technical or directly economic. It is about what we choose to spend money on. The issue reflects the complications inherent in the social construction of curriculum, to which solutions can only be found through effective collaboration between community, educators and administrators.

STATISTICS AND DEMOGRAPHIC DATA

- In assessing the impact of technology it is unfortunate that no comprehensive national surveys have been done in Australia, at least that this author could locate as of May 2000, however some analysis may be afforded of this issue by observing the following statistics from the Teaching, Learning, and Computing: 1998 National Survey Report #1, by the Centre for Research on Information Technology and Organizations at the University of California and The University of Minnesota, which was published in February, 1999. While the statistics relate to the United States (research was funded by the U.S., Department of Education) they do reflect a global trend in which Australia is a strong participant.

EQUITY IN INFORMATION TECHNOLOGY

- The resource sharing and collaborative communications extensions provided by new technologies can only do so on a broad scale if the problem of resource equity be addressed. If not, the benefits will only be provided to a few and create more disparity. Resources required include not just hardware and software, but training so that educators can manage these new tasks, and IT support staff to operate and maintain the networks that are developed. The issue of inequitable distribution of these resources lead Brady and Kennedy refer to,"…multiple forms of disadvantage…". It is due to awareness of the realities of disadvantage, that the principle of equality of distribution and access to technological resources becomes a central issue for educators. Teachers, who currently undertake roles of implementers of curriculum, of providers of civics and citizenship education, as progenitors for school review processes and in facilitating aims of continuous improvement, must now vitalise and actualise another aim, that of realising appropriate curriculum development relevant to the collaborative environment of electronically networked information and communication facilities, cooperatively in a shared environment.
- Changes to Queensland curricula such as the Schooling 2010 Project reflect the new mandate for integration of technology through the curriculum. It is important that teachers do not find that they are working towards this alone. It must involve input from all sectors of the community, and particularly those directly concerned with administration and decision making for educational budgetary allocations. It is important that there is no increase in the gulf between the information rich and the information poor, and to do this it is necessary to ensure that all educators, as far as possible, are working towards the incorporation of the tools of technology in a manner that facilitates equitable and broad distribution. Achieving this demands a broad consultative process and the elimination of short-term political agendas.

Rapid change is occurring, inequitably, with difference of opinion on how best to respond and what solutions to implement. But one thing that perhaps can be agreed to by all is that education does need to adapt to the changes at least as they are occurring. Current educational philosophies support processes which facilitate students' development of willingness to experiment, comprehension of abstract concepts, advanced skills of problem solving, reasoning, awareness of social justice and ecological-sustainability issues, all within a framework of integration of technology in cross-curricular activities.

I believe that the changes we witness in technology mean that these processes have become even more valuable. I suggest that the most needed practical application for knowledge gained at school, in the industrial and technological' real world', appears to be the ability to manifest higher-order skills within a context of thoughtful social awareness. While a background in basics remains important...what is basic is changing.

Pioneers in the use of computers and other technology in education have much to teach us about integrating technology into our classrooms. It is through their expertise, experience, observation, research, and discussion that we can learn how to best make use of the power of today's technology to teach Pioneers in the use of computers and other technology in education have much to teach us about integrating technology into our classrooms. It is through their expertise, experience, observation, research, and discussion that we can learn how to best make use of the power of today's technology to teach our students. Technology in the classroom is nothing new to education. In the past, computers were used mainly as a tool to teach basic skills through the use of "drill and kill" software. There is a place for those programmes that focus on basic skills, but educators are realizing the potential that computers have to help improve their students' education.

CHECK YOUR KNOWLEDGE

Directions: Evaluate the accuracy of each statement below.
Place a T (for True) or an F (for False) in the spaces provided.

- The use of technology in the classroom encourages the traditional role of teacher as lecturer.
- The use of technology in the classroom supports teachers in encouraging students to use higher-order thinking skills.
- Technology can be used to enhance learning when teachers put the technology into students' hands and challenge them to apply it to solve problems and complete projects.
- Even when the teacher acts as coach, sometimes the teacher needs to share important pre-knowledge before a project is presented to students.
- The term information literate is used to describe a student or teacher who looks to the media for solutions to problems.
- Technology and popular culture have slowed down the delivery of information and decreased the quantity of information available to students.
- A teacher who seeks to incorporate technology into his/her classroom to develop information literate students must provide interesting and relevant projects, questions, and problems for students to undertake.
- Computers are not teachers in and of themselves.
- Computers should be integrated into the curriculum as much as possible.
- The teacher as coach role also includes differentiating the lesson for students of varied abilities.

TEACHER AS COACH

The modern-day classroom is now moving beyond utilizing computers to simply teach students basic skills. In a research report on media and technology, Thomas Reeves made a distinction on the use of technology by clarifying the difference between "learning from" and "learning with" technology. Learning from technology implies the computer is acting as a tutor delivering instruction on basic skills. Traditionally, this has been the way technology was used in the classroom. Learning with computers implies that the computer is a tool to solve problems where students must gather, organize, and analyse problems.

This approach supports constructivist teachings and the idea that technologies are cognitive tools that can be used to expand on student learning. With the expectation that students be information literate, educators need to spend more time designing lessons where students are learning with computers rather than from them. Using the computer as a tool provides students with the opportunity to develop and use their higher-level thinking skills to solve problems that are relevant to their daily lives. As we move towards the idea of learning with technology, teachers are taking on a new role in the classroom. Hobbs (2006) points out in addition to simply bringing students access to online sources, such as online newspapers, magazine articles, and blogs, K–12 educators are now "involving students in creating their own messages using visual, electronic and digital media tools".

Technology lends itself to a new role for the teacher: that of facilitator and coach. Replacing the traditional model of a teacher as a lecturer, the teacher instead presents students with challenging real-life problems and the technology tools to solve them (Means and Olson, 1994). It is significant that as teachers take on the role of coach, students also take on a new role: that of active participants. In a research study that focused on project-based learning with multimedia, participant teachers reported the shift in their roles in the classroom. They found they were less likely to lecture and more likely to facilitate or coach students. A teacher acting as a coach can now join his/her students in the learning process, encouraging them to use technology tools to help overcome any obstacles they may face when trying to find a solution. In the end, the teacher helps students draw conclusions and assess their learning. In these activities, the teacher encourages students to use higher-order thinking skills with scaffolding provided through the highly motivational technology tools. "Teaching higher-order thinking skills involves not so much conveying information as conveying understanding.

Students learn concepts and then attempt to apply them to various problems, or they solve problems and then learn the concepts that underlie the solutions". The use of technology supports teachers in this lofty goal. The teacher as coach model is not new. Most likely you have assumed this role when you have challenged students to solve problems or complete interesting projects. You likely already know that cognitive research shows that learning improves when students are actively involved in learning, working in groups, frequently interacting and receiving feedback, and seeing the connections to real life. What might be new to you is what experts like Jamie McKenzie have discovered over the past decade—the teacher as coach, computer as a tool model is the best methodology for effective integration of technology into the classroom

(McKenzie, 2000). In other words, technology is best used to enhance learning when teachers put the technology into students' hands and challenge them to apply it to solve problems and complete projects.

- Designs projects and/or problems for students to tackle
- Asks thought-provoking, open-ended questions to guide students
- Provides tools and teaches students how to use them to solve problems
- Modifies lessons for higher-ability and lower-ability students
- Forms cooperative groups; willing to change direction of lesson based on student interest
- Evaluates skills, effort, and knowledge using a combination of assessment devices
- Leads students through self assessment processes
- Presents information lecture-style
- Demonstrates skills and directs students to mimic the steps
- Shows students how to solve problems
- Leads students to one "right" answer
- Favours having students work on their own
- Evaluates students almost exclusively with paper-and-pencil tests

A WORD ABOUT LECTURES

Occasionally, teachers still need to share information with students in the traditional lecture-style. Oftentimes, the teacher needs to share important pre-knowledge before a project is presented to students. The main idea of the teacher as coach model is to ensure that a great deal of the instruction is student-centered, with students being active problem solvers and learners. This is why technology is so exciting. Technology lends itself to project- or problem-based lessons.

HELPING TO CREATE INFORMATION LITERATE STUDENTS

Part of the teacher as coach model is helping to create information literate students. The term information literate is used to describe a student or teacher who knows how to question, think independently, invent, research, and problem solve. "As America moves towards an information society, critical thinking skills, problem solving skills, and competence in information literacy in order to process information become increasingly more important for all students" ("Information Literacy in an Information Society," 1994,. Technology and popular culture have accelerated the delivery of information and increased the quantity of information available to students. Information literate students do not simply regurgitate information. They do not immediately believe what they read. They skim, discriminate, question, analyse, and synthesize information. This is why it is so important that we create learning situations in which students are not merely instructed, lectured, or shown how to do something. Internet researcher Dan Tapscott notes that while much of the world is controlled by adults, with kids as passive spectators, the Internet gives students an opportunity to not just observe, but also to participate (Tapscott, 1998). We must prepare students for an information-saturated world, a world where adaptable thinking and solid problem- solving skills are paramount for success and, in some cases, survival. As a teacher, you have the unique opportunity to provide your students with opportunities to practice questioning and problem solving, as well as using technology tools to solve problems, answer questions, and communicate. In this way, you will help to create students who are information literate and, eventually, citizens who can navigate and succeed in our increasingly complex world.

QUESTIONS, PROBLEMS, PROJECTS—MEANINGFUL USES OF TECHNOLOGY

In the past, the teacher and texts were the only sources of knowledge for any given content area. Technology brings more exciting, up-to-date, and diverse materials right into the classroom (Hawkins, 1997). A teacher who seeks to integrate technology into his/her classroom to develop information literate students must provide interesting, relevant projects, questions, and problems for students to tackle.

So what are project-based or problem-based lessons that engage students in real-life tasks and build critical thinking skills? Such lessons begin with a question or problem that is meaningful to students because it will send them on an interesting, challenging investigation.

Examples of questions and problems include:

- What pattern do you see in the multiples of six? (3rd grade)
- How are the oral traditions of the Ashanti from Africa and the Pawnee Native Americans similar and different? (5th grade)
- Why did kings and queens live in castles? (Kindergarten)
- Does tap water have the same pH level and contain the same metals in different cities in the
- United States? (6th–8th grade)
- What is your opinion regarding the U.S., Supreme Court's ruling in favour of George W. Bush in the 2000 Presidential Election? (8th grade)
- How many students in our classroom like chocolate chip ice cream? Rocky Road? Mint chip? (1st grade)

It is important to note that all of the above questions were formed to address academic standards and can be answered (or conclusions can be presented) with the help of technology. So, how can students use technology to help answer questions like those above?

Here are some examples of projects involving technology:

- Brainstorm the answer to a question using graphical organizing software.
- Create a collective class database to collect information on a history, science, math, or language arts topic.
- Discover patterns in multiples of numbers using a calculator.

- Research literature, ancient and modern cultures, scientific discoveries, historical events, mathematical history, famous artworks, geological data, *etc.*, using the Internet.
- Participate in real scientific research using the Internet.
- Communicate (using e-mail) with other classrooms across the United States and the world to collect scientific or sociological data.
- Create newsletters, invitations, and posters using word processing software to synthesize and apply knowledge and ideas.
- Construct a persuasive multimedia presentation as the culmination of a research project.
- Use a spreadsheet programme to organize economic data and create graphs to compare that data. In the next section, you will see an example of a new teacher directing her students in a project-based lesson that incorporates technology as a tool used to complete the project.

TEACHER AS COACH IN A LESSON INTEGRATING TECHNOLOGY

The Scenario

Sophie, a new teacher, wishes to address some of the technology and science standards her district expects her to teach her fifth-grade students. She has two computers in her classroom and access to 20 more computers in a computer lab. Each computer in her classroom and in the lab has word processing, spreadsheet, multimedia, desktop publishing, and drawing software programmes, as well as Internet access.

The Project

Realizing that being a new teacher is a challenge by itself, Sophie wisely decides to borrow a lesson idea from another teacher. In this case, she goes online and finds a standards-based lesson on an education website. The lesson poses the following question to students: How is the geology of Earth similar to or different from the geology of the moon? Students assume the roles of either geologists or astrogeologists to investigate the physical characteristics of Earth and the moon.

Students are to work in pairs and use their own observations, the Internet, and books to collect their information. They are given a chart which directs them to record what they find and sources of information they consulted. Once they have collected their information, students meet with a group that conducted the opposite research (*i.e.,* the geologists meet with the astrogeologists). At these meetings they discuss what is similar and different about the geology of Earth and the moon and record the information from the other group on the backs of their papers. Then, they are instructed to create a table in a word processing document and then a Venn diagram on paper comparing the physical characteristics of Earth and the moon

Days one Through Five of the Project

Before beginning, Sophie decides to tweak the lesson a little to fit the unique needs of her students. She decides, for example, that her students need to know a little more about conducting research on the Internet before the lesson. She spends day one in the computer lab showing students how to use a kid-friendly search engine to find information. She uses a computer projector attached to the teacher's computer to show students the steps.

Then Sophie gives them time to practice on their own. In the computer lab on day two, Sophie asks the students to recall from previous lessons the definitions of the terms geology and physical characteristics. She then uses the computer projector to show the students pictures of Earth and the moon. Next, Sophie asks the students to spend time in small groups discussing and writing down their hypotheses for the question: How is the geology of Earth similar to or different from the geology of the moon? Then she assigns the pairs of students to either the role of geologist or astrogeologist. She pairs students who are more familiar with technology with those who are less experienced.

She asks what the differences are between geologists and astrogeologists; students discuss this in small groups before offering suggestions. She tells students to use the Internet to find the physical characteristics of either Earth or the moon, depending on their assignment. While they are looking for information, Sophie walks around the classroom, listens to the students talking and working, and peeks at their computer screens. She assists students by talking them through any obstacles. She provides information when necessary to scaffold the lesson for struggling students. However, she resists the temptation to lead them directly to the answers.

On day three back in the classroom, Sophie provides geology books of varied complexity to students and presses them to find more physical characteristics of Earth or the moon. For those students with a complete list, she challenges them to choose one physical characteristic, predict how it was formed, and then find the answer using a classroom computer or a book. After students are given a little time, Sophie then directs pairs of students to meet and share their research. She explains that this is what scientists do: they share their research in order to further everyone's knowledge and build upon existing knowledge.

The pairs then exchange their research. On day four back in the computer lab, Sophie uses the computer projector to briefly remind her students how to create a table in a word processing document, which is a skill her students had learned in a previous lesson. The students are creating tables to display their research and the research of the other group. On day five, students work by themselves to create Venn Diagrams on paper, comparing and contrasting the physical characteristics of Earth and the moon. Sophie assists students who need help to complete their diagrams. As the students finish, they meet with other students who are finished to discuss their findings. Finally, students explain in writing how their original hypotheses were correct or incorrect. They are also told to think of reasons why the physical characteristics of Earth and the moon are similar or different. Students with time to spare are encouraged to use the classroom computers and books to explore this final question further. When everyone is finished, the class comes together to discuss that final question.

COMPUTER AS THE TOOL

In the lesson above, you can see that Sophie did not rely on the computers to teach her students. She did not sit them down in front of the computers and have the students use a software programme to learn facts or skills Computers are not teachers. When technology is used as a tool, the students and teachers are in control of their learning and the direction their learning takes. Using computers as a tool allows students to use higher-level thinking skills to solve problems. The power of technology lies with how the teacher uses it. As in Sophie's classroom, the computer acted as a tool for students to explore and gather information to support a problem-based project. Think of a computer as you would a pencil, ruler, compass, or microscope. We do not expect these implements to teach skills or knowledge to students. We use them with students as tools to help students make new discoveries and solve problems. Software that facilitates critical thinking and higher order thinking works best with the teacher as coach, computer as tool model. Using these tools helps students to question, plan, gather, analyse, and report. Examples of these software programmes include databases, word processors, spreadsheets, multimedia presentation programmes, publishing programmes, and graphic organizing programmes. Of course, there is an occasional place for allowing students to use computer programmes that help reinforce learning already taking place in the classroom.

Instructional software programmes that help students practice math facts or new vocabulary can be helpful when used now and then. Some high quality programmes, like The Logical Journey of the Zoombinis, can also lead students through problem-solving exercises that involve logic and reasoning. When planning a lesson incorporating software, remember that teaching students how to use the programme is not enough. Think about why the students are using the programme. What project can they accomplish? What question or problem can they solve when they use the programme to create a product? In the above lesson example, students first used the Internet to collect information and help answer a question. Then they used a word processing programme to create a table to compare their research to another group's research

OBTAIN FUNDING FOR TECHNOLOGY INTEGRATION

Do you have a lesson idea or project that involves technology, but you need extra money to bring it to fruition? Lack of school or district funds for educational projects is an ongoing stumbling block to teachers with exciting ideas. According to a National School Boards Association (NSBA) survey reported in 2005, funding for technology and incorporating technology into the classroom are among the leading challenges that school districts confront in the area of technology. Therefore, teachers must be creative when seeking funds for technology-related projects.

However, if you take your time, search on the Internet, look through professional journals and magazines, and contact local businesses and foundations, you will most likely find a way to fund your project. "Having a well-conceived and descriptive technology plan is a critical factor for success when seeking technology funding".

The focus of Chapter Nine is to explain the grant writing process. This includes how to prepare for a grant by collecting relevant data, where to find money to support a project, how to effectively write the standard eight components of the actual grant, and the important things that teachers need to remember as they work through and complete the grant writing process.

CHECK YOUR KNOWLEDGE

Directions: Evaluate the accuracy of each statement below. *Place a T (for True) or an F (for False) in the space provided.*

- Grant administrators are interested in funding projects, not materials and equipment.
- Including a project goal and multiple objectives in a grant application is optional.
- The method explains the project sequence from start to finish.
- There should always be a direct correlation between the project evaluation and the project goals and objectives.
- The introduction is where you have the opportunity to describe your classroom, school, students, and community.
- Statistics about the school, students, or classroom are included in the section with the project goals and objectives.
- The components or criteria that are listed in the grant application are only suggestions.
- If the grant proposal is rejected, it is always a good idea to ask the organization for a copy of the comments related to their decision.
- A grant application has a better chance of being accepted if it is shown that it can be replicated in other situations or areas.
- Grant proposals can stem from existing ideas to which a new twist or different component has been added.

WHAT IS A GRANT

It is expensive to increase the amount of technology and technology education in a classroom, school building, or school district. Since many schools have tight budgets, the question becomes: Where are teachers or school administrators to find the money to fund additional technology- focused programmes? The answer: grants.

So what exactly is a grant? It is an award of a specific amount of money to an individual or organization to finance a particular activity. It helps with specific costs involved in the implementation or continuation of a project. Grant applications take planning and commitment. However, the potential payoff is that the grant money can help teachers or administrators provide outstanding educational opportunities for students.

Getting Started

To get the grant process started, come up with an idea for the grant proposal. While preparing the documentation can be time-consuming, the more planning and preparation you do, the more successful you will be in acquiring the funding, especially if you already have a well-organized technology plan (Sun et al., 2000). It is important to expand your proposal beyond acquiring technology; grant funders want to support projects that focus on improving student learning or on research-based solutions.

Even if the goal is professional development, the eventual end needs to demonstrate that it will affect student success. Brainstorm with individuals who will benefit from the project to generate ideas for a potentially better grant project. However, it is not enough to have a good idea. Good planning is essential to the proposal's success. In addition to brainstorming, research the feasibility of the project.

A few questions to ask during this process are:

- What do you want to do, how much will it cost, and how much time will it take?
- What difference will the project make for students or the learning process?
- What has already been done in the area of your project? By whom? What were the results?
- How does the project fit within the curriculum?
- Is the project focused on one classroom, or can it be replicated throughout the entire school or in other schools?
- How will you accomplish your project? What is your plan of attack?
- How will the success of the project be evaluated?
- How will the project be maintained once it is implemented?

Finding the Money

Once you have a grant proposal in mind, you need to find the appropriate funder. There are two main sources for funding-the public and private sectors. Public funders are usually organizations at the state or federal level. The grants that they offer are very competitive and have more complex requirements than other grant programmes. They tend to fund large-scale projects, which are usually geared towards school districts rather than individual teachers. Public grants may require partnerships with other institutions (*e.g.,* libraries, museums, or community organizations).

Typically, public grants have only one deadline per year. Private funders are foundations and corporations. They are private entities, usually not-for-profits, set up for the sole purpose of giving away money to support certain goals or projects. Private funders are excellent sources of funding for individual classroom projects. They tend to offer dollar amounts that are more appropriate for classroom projects than for projects at the district level. The grant proposal process can be much simpler, and there are often multiple deadlines each year. There are several places to look to find just the right private funder.

Start by looking at the following: o District educational foundations.

- Top ten employers in the community
- Technology vendors
- Websites such as" The Foundation Center"

As you look for a funder for your project, it is important to review the eligibility requirements. Funders are very specific about what they will and will not fund. For this reason, it is important that you contact them for more information. Keep in mind that there is nothing wrong with asking the funder for suggestions as to how to enhance your application! It is important to figure out the cost of each component in the total plan so that you can know where to cut back if the whole project is not funded. Also, consider the amount of award money each organization is willing to give. This will determine if you need to submit several proposals to multiple organizations in order to cover the costs of the project. Districts can create three- to five-year plans and implement various phases, which is important if you are not able to get funding for each component of your technology plan. Finally, it is very important to consider the grant deadline. It takes time to write a successful grant. It is not something that can be done in a week.

Writing the Proposal

There are several components to a proposal:

- Proposal summary (or abstract)
- Introduction of the organization seeking funds
- Problem statement (or needs assessment)
- Project objectives or description
- Project methods or design
- Project evaluation
- Project budget

Proposal Summary

The proposal summary outlines the proposed grant project. It should include brief statements that explain the problem, the solution, the funding requirements, and information about the people involved with the project. Depending on the funder's requirements, the proposal summary could be a cover letter or the initial page of the proposal. Regardless of its location, it should be brief, no more than two or three paragraphs, or about 250–500 words. Oftentimes, the summary is written after the grant proposal has been developed, to ensure that all the key points of the project are included. The proposal summary becomes the foundation of your proposal. It gives the grant reader a first impression of the project. In many cases, the summary is the most carefully scrutinized and reviewed part of the grant application.

INTRODUCTION

The introduction is the place in the grant proposal to share information about your classroom, the students, the school, and the community. The introduction could also be called "Statement of Need." This section enables the reader to learn more about the problem that you and 200 your students face. It presents the necessary facts and evidence that support the need for the grant project. It helps to establish that you recognize the problem and are willing to work to find a solution. The information or statistics that are used in this section can come from building- or district-wide sources or from your classroom observations.

THE PROBLEM STATEMENT

The problem statement explains the need or the purpose of the project. It needs to be supported with evidence that stems from specific experiences or statistics from reliable sources. It is important to stay focused on the project's purpose and describe the present problem.

THE PROJECT DESCRIPTION

The project description should include the goal(s) and objectives of the grant project. "Good goals are at the core of all good proposals". The goal states the purpose of the project. The objectives are the measurable outcomes of the grant project. They specify concretely how the project will improve student learning. It is not enough to say you just want to buy things because you do not have them; you must explain how the technology will act as a tool for improving the learning environment. As you consider how to write the objectives for the grant project, it is important to remember that there are four different types of objectives: behavioral, performance, process, and product.

A behavioral objective focuses on what the student or teacher does. A performance objective pertains to an expected level of proficiency after the project is complete. The process objective refers to how the grant project will be documented as it progresses. The product objective states or describes the final product that is generated by the project.

THE METHOD

The method section is where the project components are detailed. It describes the how, the when, and the why of the grant project. You need to describe how the project will progress from start to finish, when each component of the grant project takes place, how the project will be staffed, and why the project is significant enough to make a difference in student learning. Most funders also want to know how you will sustain the project after funding runs out, so be sure to include this explanation.

The Evaluation

The evaluation component of the grant application explains how the project will be evaluated. It should also explain the method that will be used to evaluate the project and who will be doing the evaluation. Funders are interested in technology plans that measure success, identify possible problems, and ask questions for future research. In addition, this section must show a direct correlation between the evaluation process and the goals and objectives that were described earlier.

The Budget

The budget section of the grant application has several purposes. It is used to explain the project from a monetary standpoint. It should contain an itemized list of all funds needed for the project, an itemized list of items and funds that have been supplied by the school or teacher, and an itemized plan for future funding. It is important to remember that the budget is not just an accounting of possible expenses, but it is also a way for the grant seeker to describe the project in monetary terms. Most importantly, the budget should relate all of the project costs with the project objectives in dollars and cents. Do not round numbers up or down. It is also important to clearly explain how the budgeted items were calculated.

Things to Remember

As you work through the grant writing process, there are several things that you should remember. First of all, do not become discouraged if you receive a rejection from a possible funding source. In most cases, there are large numbers of people applying for each grant that is available, and the funders have only so much money. Therefore, just because the grant is turned down, it does not mean that it is poorly written or not worthwhile. Sometimes, you can obtain the reader's comments and resubmit with success accruing to the remarks made. Second, it is very important to read the funder's guidelines and instructions carefully.

The closer you follow the directions and the presentation requirements, the higher your chances of qualifying for funding. Make sure that no steps are skipped. If you read the Request for Proposal (RFP) carefully, you will not waste valuable time (yours and theirs) by submitting a proposal that does not meet the funding requirements. Because the funders are giving away their money, they have the right to determine exactly what information they want to ask in the grant application. It is also essential that you do not try to make the funder's programme fit your project.

Your project must be in line with the funding agency's priorities and expectations. Third, the project and all of its components should be innovative, creative, and educational. Funders want to give money to projects that are unique and show a lot of forethought. That does not necessarily mean that the grant project has to be a new idea. There is nothing wrong with taking an existing idea and altering it to meet the needs of a different grant or application. Note that funders, public or private, will rarely fund construction or existing operating expenses. They want to fund the projects that will make a difference in a specific area of interest.

For the most part, they usually invest in supplemental programmes. Private foundations often seek creative solutions to problems/needs, but they usually do not wish to fund risky projects. It is important to keep your ideas and goals realistic. It is very easy to come up with a far-out or really awesome idea for a grant project; however, if the project or the goals and objectives that are written for the project are too extreme, it is very possible that the grant request will not be funded. Fourth, it is very important to have an evaluation plan. Funders want to know if the projects they fund will be successful. They want to know if the project is meeting its goals and your proposal should include how you will determine its success. Fifth, make sure that your project is replicable. The funder wants to know that the grant project can be duplicated in other locations or situations.

Explain how the project can be extended to other grades or schools. Sixth, have a reasonable, detailed budget. It is extremely important to do the necessary research on all costs associated with the project prior to submitting the application. It is also very important to explain the budget even if there are no requirements to do so.

There should never be any doubt or concern with regard to the budget. Lastly, proofreading is one of the most important steps in the grant writing process. Spelling and grammar errors do not convey a positive image. The funders are relying on the grant proposal as the first impression. If the application is poorly written or has multiple mistakes, it tends to give the impression that it was slapped together or written in a hurry.

Also, never use abbreviations or educational lingo that a "non-teacher" would not understand. Most grant reviewers are not educators. If possible, have a friend or family member who is not an educator 204 read the grant application to look for education lingo. Even the term cooperative learning is not well-known outside of the education profession. Obtaining grants can make your educational projects possible. Do not let your classroom budget limit you. You can bring unique learning opportunities to your students, boost your school's profile, and inspire other teachers to dream a little bigger by your example.

QUESTIONS FOR FURTHER CONSIDERATION

In the following section, I present questions to prompt teachers' awareness of and work towards each of the educational technology integration and implementation principles (eTIPs). I designed them to be used by teachers while planning instruction in order to guide their thinking through the additional issues and questions that are raised when integrating and implementing technology. After determining the lesson or unit objections, consider the following additional issues and questions about the appropriateness of integrating technology into the instruction.

Questions for eTIP 1: Learning Outcomes Drive the Selection of Technology

- Which objectives or standards does the technology complement and support?
- Are these mainly content area objectives or process skills?
- What is the cognitive demand on the learner as they use the technology?
- After determining your lesson or unit objections, the following questions guide teachers' thinking through adding value by integrating technology.
- How does using the technology add to what the teacher or students can do?
- Compared to other resources, what added value does the technology bring to the teacher or students' work?
- What are the costs and benefits? Do students have sufficient skills with the computer_s operating system to use the technology?
- What menu items or operational skills do students' need to use the technology?
- Will developing the necessary prerequisite skills require extensive instructional time? Would all students need these prerequisites or could students be grouped with an expert"?
- How does the time required for the integration of the technology balance with the instructional goals and objectives?
- Would using the technology require the teacher to overcome inordinately difficult logistics?

Questions for eTIP 2: Technology Assists in the Assessment of the Learning Outcomes

- What criteria will be used to evaluate student work?
  In the assessment, will students' capability with the software also be assessed?
- How can the students' technology-supported work help you learn what they know and can do?
- How does a technology-supported performance demonstrate progress towards specific content standards?

These next questions can help teachers to determine whether or not the access to educational technology is ready enough that the added value provided by the capabilities of the educational technology outweighs the effort required to work through any logistics.

Questions for e- tip 3: Ready Access to Supported Technology is Provided

- What technology will the students or teacher need to complete the task?
- Are enough of the technology resources available during the timeframe
- you will need them? Are the resources available in locations and configurations that fit your time and space needs?
- Does the level of availability of the technology resources suggest that students will work individually or in groups for the different tasks or components of the lesson?
- Who is available to assist with the setup and troubleshooting of the technology resources? How quickly can they respond if you need assistance?
- The following questions can guide teachers as they determine any learning needs they have for the technologies they are considering using.

Questions for eTIP 4: Professional Development is Targeted at Successful Technology Integration

- What professional development or instructional support might you need to implement this technology integration?
- Are there online resources, classes, or individuals that could show you how to operate the technology?
- The questions below could be used to guide teachers' thinking through the additional issues and questions that are raised by integrating and implementing technology in a collaborative professional community.

Questions for eTIP 5: Teachers Reflect, Discuss, and Provide Feedback about the Role of and Support for Educational Technology

- With whom can you talk or share to gather insight about your integration experiences?
- How can you capture your integration experiences to share them with others?
- How will you make your integration experiences more public, so others can learn from you?

CONCLUSION

In addition to helping teachers recognize and plan for the effective technology use, the educational technology integration principles (eTIPs) can be adapted for other purposes. For example, job candidates might use them as a framework to organize questions to ask during an interview, and to determine whether or not they might like the technology environment at the school site, if offered a job. Generating indicators for the presence of each principle could be used as a checklist by a school technology team to conduct a needs assessment. Teachers could use them to determine the kinds of input and guidance to provide during technology planning or evaluation efforts.

Overall, these educational technology integration and implementation principles point out the two key aspects of teachers designing effective integrated instruction: The technology use must match and support teaching and learning and the larger school environment must provide support for the logistical and learning demands technology integration puts on teachers.

CHALLENGES

Technology is a buzzword in the educational field today. Many questions arise regarding the integration of technology in schools. Should technology be incorporated into schools? How should technology be integrated? Why should technology be incorporated? These are key questions being raised throughout the world of education. Will technology ever be fully integrated in schools? What are the barriers and constraints? How does teacher education, pre service or in-service affect the integration? How do we get around the budgetary concerns? How do we convince teachers to embrace technology?

How to proceed? These questions will be discussed in this paper, as will solutions to the question of how to overcome the challenges with integration in schools today? Computers offer exciting approaches to teaching that were not even dreamed of twenty years ago, but the extent to which the educational potential of computer technology will be realised remains to be seen. Some teachers will use computers to revolutionize their classrooms. These comments communicate the beliefs of many educators and parents about the promise of computers and technology and their ability to have an effect on how students will be educated.

If used correctly, today's technologies have the opportunity to improve education dramatically. How can technology help? According to the Education Commission of the States (2001), Technology is helping teachers tailor instruction towards student needs, making possible a student-centered learning environment, aligning standards, allowing for testing and diagnosis, allowing teachers to manage classes and administrative duties more efficiently and letting teachers pursue professional development opportunities more easily.

Technology is helping students, including students with special needs and those at-risk, acquire necessary skills, participate in mainstream classes, prevail over limitations, physical or learning, work on real-world problems, communicate with peers around the world, improve their tests and gain access to computers when it otherwise wasn't available. With technology, average students would make substantial improvement and higher-level type students would have no limitations.

Literacy would no longer be a concern and lower level and handicapped students would have new prospects. Technology is helping administrators show accountability for goals, use data to learn about effective practices, manage information more effectively, improve communications between parents, teachers and students and provide different opportunities for parental involvement. What about the future of technology in education? There are many stories of successes when computers and technology are implemented in schools; there are also many stories of failures, technology that isn't fulfilling its promise of improving our students' education.

Most teachers understand the potential of integrating technology into curriculum and the changes it will make to the education field, but many know that technology's full potential won't be reached until it can be fully integrated in the classroom and not just used as a supplement to traditional teaching.

As the 21st century continues to roll on, educators and administrators are faced with many issues. Budget concerns, insufficient funding, the over regulation and micromanagement of schools, challenges of school leadership, the politics of education, teacher turnover, teacher quality, the No Child Left Behind Act standardized test scores, and potential referendums are issues that all schools face.

But perhaps one issue that gives school districts the biggest headache is technology. The concerns with technology and schools are many folds and a constant concern of administrators, educators and school boards. While there are numerous points to deal with when discussing implementation of technology in schools and into curriculum, the main roadblocks can be broken down into the following issues:

- Money or technology budget
- Time, teacher's reluctance to technology, and teacher's attitude towards technology
- Lack of teacher education in technology, formal and informal training, including mentoring, and lack of experience
- *Administration Leadership:* Vision, support, and planning

Hardware

Software

The purpose of this paper is to examine a few of these challenges and each one's effect on integrating technology into schools. While all of these challenges are important, hardware and software concerns will not be discussed. This paper will discuss the challenges of money, time and reluctance of teachers, teacher education and leadership of administration.

MONEY

No discussion about the challenges affecting the integration of technology in schools could begin without discussing money and budgets for technology. Technology's costs are substantial and continue long after the initial purchase. It is important to discuss the initial funding of technology and the ongoing cost of keeping the technology. If districts are not prepared to budget annual funds for the maintenance and support of technology, then the money spent for equipment would be better used for something else (Education Commission of the States, 2001). Not only do districts have to fund hardware and software, but it is necessary to fund teacher education as well. In fact 20% to 25% of a school's technology budget should be spent on teacher education. School districts all over have increased their technology budgets and this rise in outlay has increased the number of computers in schools. This increased amount of technology however is ahead of the curriculum planning necessary to integrate it. Developing innovative uses of technology is vital to improving and developing student learning Schools cannot just buy and install the technology and expect it to make big changes.

TIME AND TEACHER RELUCTANCE

Time and the idea of implementing technology in education are sometimes at odds with each other. Teachers claim to not have enough time, students claim to not have enough time and administrators claim to not have enough time. Some experienced teachers will claim that this is the key reason for their reluctance in welcoming technology. To them, more time spent playing with technology would mean less time spent learning. Less learning time is something that many teachers aren't in favour of and won't accept.

Time is a problem not only on the side of instruction. Teachers, especially less experienced teachers, need more time to learn and prepare when using new technologies. More time learning about technology means less time preparing for lessons. In addition to learning about technology, teachers must spend time matching software with curriculum, scheduling computer lab time, troubleshooting, monitoring use and supporting students when using the technology.

All of these things take more time from teachers' standard prep time. When it is all said and done, great burdens are placed on teachers' time, imagination and creativity. "Teachers need time to acquire technology skills and develop new teaching strategies for integrating technology into the classroom. Except for occasional in-service programmes, teachers often have no time built into the school day for their own professional development" Programmes scheduled for after school have been less successful than in-service programmes or summer programmes

CURRICULUM AND TECHNOLOGICAL CHANGE

Technological change is redefining not only how we communicate, but in turn, is redefining how we need to educate. The ready availability of information has lessened the necessity of ROTE learning, but raises new issues in terms of effective searching and the development of an ability to evaluate information.

The development of analytical skills and higher order thinking is increasingly an important focus. The stakeholders and interest groups in this process are many and varied, with pressure for change and reform brought from teachers, schools and school councils, government authorities, industry and students themselves. All have differing perspectives on the best curriculum planning models to deal with this change. The roots of change are in an increase in technological and networking capacity, but what are the ramifications for curriculum development, and interpretations necessary for the classroom? Many educators hold the view that computers and Internet connectivity are "tools" for learning and thus, believe an increased grade point average is often the only measure of value for technological resources.

However, an important perspective for all educators, government administrators and school boards to consider is, that networking represents not just a new set of tools, but a new environment for learning and teaching. New communications technologies encourage new possibilities and develop new requirements. An outcomes based education policy must accept that the new communications technologies must impact upon core curriculum requirements and will influence diversity, context, assessment issues and practice. It is important to place our interpretation of current curriculum into as strong a future-proof context as possible and eventually, but not in the distant future, every student will need access to the information represented on the web in order to be competitive in their workplace.

TECHNOLOGY AND VOCATIONAL PREPAREDNESS

While there are still liberal-humanist influences on our education system, a fundamental orientation of state secondary education is directed towards an economic-rationalist agenda of vocationally orientated educational outcomes, which in theory target industry needs. Brady refers to this as, "… human-capital theory" (Brady and Kennedy, p67, 1999). Whether or not education based on this framework is a sound policy is in itself a topic for detailed analysis, but for the purpose of this dialogue I will not contest that vocational preparedness is a central preoccupation of the education system, and instead, focus on the way curriculum addresses this agenda.

In what ways do the possibilities of technology influence curriculum designed and developed to address vocational outcomes? Traditionally, major decisions related to education course content arrive top down from administration. They are then implemented by teachers who, frequently, spend all but a small portion of their day confined to a room in which students are rewarded for working quietly and independently. In contrast, success in business relies on collaboration and teamwork. The traditional education system is just beginning to transform into an environment that encourages collaboration as a focus in learning. Emerging technologies can catalyse this change and in fact encourage new systems of collaborative development.

This is a fundamental transformation, in which the archetypical education system, in both theory and practice, now has the tools, not just the incentive, to facilitate a transition from a focus on providing information, to a focus on developing collaborative conceptual frameworks for educational activities. Educational practice should be located in a way that incorporates the demands of a vitally changing world, increasingly dominated by the technologies of electronic communication and collaborative networking.

5

Challenges in Advancing Education Through Technology

THE ADVANCEMENT CHALLENGES OF EDUCATION THROUGH TECHNOLOGY

In recent years, Open Course Ware (OCW), an academic initiative that gives the public access to much of the same information used in undergraduate and graduate programmes at institutions of higher education, has greatly improved the quality of educational material available for free on the Internet.

The idea of Open Course Ware gained prevalence in 2002 when MIT began distributing academic material from courses to the public for free. Through the early 2000's, this idea began to gain popularity with other colleges and universities.

As of 2008, there were close to 150 collegiate institutions that had operational Open Course Ware programmes, or were in the process of planning such programmes.

These institutions include Harvard, Princeton, Stanford, University of Pennsylvania, and University of Michigan. Such programmes are an example of how technology can allow more people to have access to information and resources that have originally only been accessible to students at prestigious universities.

A NEW THEORY OF HUMAN DEVELOPMENTAL STAGES

Emphasizing that in the last decade many Japanese psychologists have expressed the view that developmental stage theories are almost dead, Abiko has proposed a new theory of six developmental stages based on children's shifting interests and brain development

In Abiko's words:

- In the course of growth, a child's interest center moves from a focus on skills and repetition, through phases of language development, memorization, and imitation, then to general concepts and logical or critical thinking, then to self-searching and self-development, and finally to self-realization. Accordingly, my proposal for a whole-school curriculum structure from elementary through secondary levels follows the first five stages.

On the basis of the Shifting Interest Center Theory, Abiko proposes a structure for the whole school curriculum or education programme as part of an overall lifelong education process. That is, the educational content of the school curriculum can be divided into three basis categories:

- Life morals and skills,
- General (main) concepts and methods, and
- Logical thinking and creativity.

INFORMATION PROCESSING FRAMEWORK

These issues can be explained within the HIP framework. The central components of the framework are the innate cognitive architecture, the mechanism of learning, and the procedure and the representation that are created for information processing. HIP has become a popular approach to the study of learning. This is because the HIP approach provides psychologists with a framework for investigating the role of a learner that behaviourism had ignored. Cognitive psychologists have come to rely more and more on ideas borrowed from the HIP approach.

Regarding what develops in the information processing system, the HIP theory answers that the basic components do *not* develop because they are innate. What develops is the control process that manipulates information. For instance, strategies adults use to process information in short-term memory are likely to be very different from the strategies children use. The general solution to this problem has been provided by research on memory development and strategies for encoding the information acquired. A corollary of this is that the type of information stored in long-term memory will change as strategies develop.

Given the same memory task, for instance, a fouryear- old child is likely to use different encoding strategies and thus show different recall. That is why the HIP theory encompasses a large number of research studies in such areas as *perception*, *attention*, *memory*, and *comprehension*. As children grow older, however, their memory space grows with them so that they become able to process more interaction at one time, improving their cognitive performance. Control processes in both short-term and long-term storages are very convincing candidates for developmental change.

The main development of recognition is not in the ability to do it but in the complexity of what is taken in and later recognized. As children grow older, they can remember more information about the stimulus and can discriminate smaller differences between the familiar stimulus and the novel one over a longer period of time. That is to say, the basic structure of memory is not thought to change during childhood, although the size of the working memory storage may increase.

KNOWLEDGE VS. MIND

The Piagetian model and the HIP approach are both based on one key idea: there are psychological structures (such as operations, concepts, working memory, and intelligence) in children's minds that explain their behaviours. Psychology is the study of the individual maturation or learning, or individual construction of an internal model of outside reality, or some combination of such factors in the individual mind. The work of Vygotsky, who proposed theories of child language development, is considered as the third major model of cognitive development: one of major disagreements was that Piaget believed that development would precede learning, whereas Vygotsky believed that learning would precede development.

Mind

Piagetians stress that learning is neither a product of language nor a product of perception. Learning results from contradictions that lead to states of disequilibria. Piaget observed unknown facets of child thought and behaviour more than anybody else did, and proposed that children pose inherent desires to maintain a sense of organization and balance in their conceptions of the world. For Piaget, scheme is organized pattern of behaviour or thought, and his basic principles of cognitive development involve organization (tendency to combine mental processes into more general systems), adaptation (tendency to adjust to environment), and equilibration (tendency to organize schemes for better understanding of experiences). These principles are important for children to learn. In organization tendencies, children think of "cats" and "dogs" as subcategories of the more general category "animals."

Knowledge

HIP theorists focus on the difference between an expert and a novice performing the same task: expert chess players see configurations and familiar patterns of pieces on the board, but poor players see individual pieces. As children learn a skill, they acquire and store increasingly complex knowledge about the skill. There is a considerable difference in the knowledge that the expert and the novice possess; this difference affects such factors as how a task is approached and what information is sought. For the HIP researchers, children are regarded as universal novices on tasks. In chess tournaments, for example, Chi stresses that the amount of knowledge an individual possesses about a specific content area can determine to a large extent how well the individual can perform in both memory and metamemory tasks. Compared with younger children, older children and adults are better predictors of their own memory performance because they can judge the usefulness of certain strategies for a task.

THE REJECTION OF THE STAGE THEORY

One of the reasons for HIP's rejection comes from the concept of metacognition to explain why children of different ages deal with learning tasks in different ways, explaining as follows: when seven-yearold children are taught how to use both a less effective technique (*e.g.*, simple repetition) to remember pairs of nouns and a more effective technique, most of them are likely to use the less effective strategy when given a new set of pairs to learn.

Most 10-year-old children are likely to use the more effective strategy. This explanation implies that the seven-year-old children have not had enough *learning experiences* to recognize that some problem-solving strategies are better than others. This lack of metacognitive knowledge makes true strategic learning impossible for young children. Metacognition covers everything children can know that relates to how information is processed. For HIP researchers, the candidates of their search for "what develops" are basic capacities, strategies, metacognition, and the knowledge base.

Behaviourism is closely associated with the stimulus-response psychology. For classical behaviourists, the structure of cognition was an associative chain of mediating responses. As the content of associations is entirely the product of learning, the structure of cognition is thus entirely the product of learning. Behaviourists assume that the outcome of learning is change in behaviour, and they emphasize the effects of external events on human subjects.

In addition, behaviourists stress that children are motivated when promised praises or rewards (*i.e.*, extrinsic forms of motivation) reinforces their behaviour. Skinner demonstrated that organisms tend to repeat actions that are reinforced and that behaviour can be shaped by reinforcement. Skinner further developed the technique of programmed instruction (teaching machines) to make it possible for children to be reinforced for every correct response. Supplying the correct answer, teachers can motivate students to move on to the next step. For behaviourists, the specification of laws relating observable stimuli to measurable responses is sufficient for human learning.

BEHAVIOURIST VIEWS OF LEARNING

Behaviourism is one of the most dominant among the modern theories of learning. The behaviourist school is very comprehensive and it includes a variety of thoughts. However, all these thoughts suggest a common approach to learning in terms of the development of connections in the organism between stimuli(S) and response(R). Based on laboratory experiments with animals, behaviourists concluded that learning is a process by which stimulus and response bonds are established when a successful response immediately and frequently follows a stimulus.

They assumed that people are similar to machines, and considered any reference to the rule of mind irrelevant. Behaviourism holds that the subject matter of human psychology is the behaviour or activities of human beings. The behaviourists have put forward three main laws of learning: Law of Effect, Law of Readiness and Law of Exercise. The Law of Effect stresses the importance of the effect of a response. Satisfying results reinforce the response while annoying results weaken it. Reward and punishment are, therefore, important ingredients of learning. The law of readiness indicates the student's willingness to make S-R connection while the law of exercise relates to strengthening the connection through practice. Behaviourists consider learning a formation of habit through conditioning which links desired responses to stimuli. The prominent theorist among them is B.F. Skinner who propagated the idea of operant conditioning.

EDUCATIONAL IMPLICATIONS

The Behaviourist approach to learning has significantly influenced modern educational practices. Behaviourists have conceived teaching as manipulation of environment to produce desired behavioural changes in learners and thus make education more effective.

They suggest the adoption of the following three principles in the teaching-learning process:

- Knowledge of result and use of positive reinforcement,
- Minimum delay in reinforcement, and
- Elaboration of complex behaviour by dividing learning into a series of small steps.

One of the major contributions of behaviourists to education is their emphasis on defining *teaching objectives in behavioural terms*. They have stressed the need for stating objectives in the form of overt behaviour which can be observed and measured. The role of teachers becomes very crucial in deciding the changes of behaviour in their students when they learn and teaching in such a way that can students make attain those behavioural changes. Behaviourist principles have influenced the contemporary approaches to evaluation also. For instance, based on the hierarchy of learning outcomes, Bloom has suggested a model of 'taxonomy of educational objectives'. Another educational implication of the behaviourist approach is individualising instruction such as 'Personalised System Instruction (PSI)' based on the reinforcement theory that has been widely used in education.

Skinner's Theory of Operant Conditioning

Skinner propagated the theory related to stimulus-response behaviour and reinforcement. In his view, learning is a change in behaviour. As the student learns, his responses in terms of changed behaviour increase. He therefore, formally defines learning as a change in the likelihood or probability of a response.

The operant conditioning is a learning force which effects desired response more frequently by providing reinforcing stimulus immediately following the response. The most important principle of this type of learning is that behaviour changes according to its immediate consequences. Pleasurable consequences strengthen behaviour while unpleasant consequences weaken it. In operant conditioning, learning objectives are divided into many small steps/tasks and reinforced one by one for teaching purpose. The operant — the response behaviour of act — is strengthened so as to increase the probability of its reoccurrence in the future. Three external conditions — reinforcement, contiguity and practice — must be provided in operant conditioning.

Reinforcement

The most important aspect of Skinner's theory of learning relates to the role of reinforcement. An organism is presented with a particular stimulus — a reinforcer — after it makes a response. In given situation, the organism will tend to repeat responses for which it is reinforced.

Skinner distinguished between positive and negative reinforcements. Positive reinforcement is a stimulus, which increases the probability of desired response. The positive reinforcement is a positive reward. Praise, smiles, prize money, a funny television programme, *etc.*, are the examples of positive reinforcement. In negative reinforcement, the desired behaviour is more likely to occur if such stimulus reinforcement is removed. For example, we can close windows and doors to avoid hearing loud noise; we can avoid wrong answers by giving right answers. Here 'noise' and 'wrong answers' are negative reinforcers. Thus a negative reinforcer is a negative reward the avoidance of which gives us relief from unpleasant state of affairs. Skinner did not equate negative reinforcement with punishment.

Educational Implications

The basic implication of operant conditioning to teaching/instructional activities is dependency on observable behaviour. For Skinner, reinforcement facilitates learning. Further, he thinks that the most effective control on human learning requires instrumental aids/teaching aids.

Broadly, Skinner's theory has made the following contribution to the practice of education in teaching:

- *Teaching Machine*: Teaching machine, in the sense of a systematic approach to teaching with the help of machines, deserves attention as it has strongly influenced education both in theory and practice. In this approach, machines present the individual students with programmes containing a set of questions to be answered, problems to be solved, or exercises to be done. In addition, they provide automatic feedback to the students. Teaching through machines and electronic gadgets encourages students to take an active part in the instruction process. Use of mechanical teaching devices has the following advantages:

- Right answer is immediately reinforced. Machines encourage and force the students to come up with right answers.
- Mere manipulation of the machines probably, will reinforce sufficiently to keep an average student busy at a task for a prescribed period.
- Any student who is forced to leave a learning activity for a period of time may return at any time and continue from where he left off.
- Each student may proceed with his learning task on an individual basis at his own pace.
- The teacher is forced to arrange and design the course content carefully in a hierarchical order.
- There is constant interaction between the teaching material and the student, thus sustaining activities.
- After knowing about the progress of the student, the teacher can supply necessary supplementary reinforcement. Thus, machines make it compulsory that a given material be thoroughly understood before the student moves on to the next set of material.

• *Programmed instruction*: Programmed instruction is a self-learning system in which the subject matter is broken into small bits of information and presented in a logical sequences. Each step builds deliberately upon the preceding one. A student progresses through the theme that is being taught through the programme. At the end of each step there is a question to be answered by the learner. After the question is answered, the learner is expected to check his/her answer with the correct answer supplied in the programme. This is an inbuilt feature of programmed material.

Cognitive Approach

Cognitive approaches mainly deal with the psychological aspects of human behaviour. 'Cognitive psychology' has taken an important place in the psychology of learning over the last three decades. While conducting experimental investigations, cognitivism takes into consideration activities such as perception, concept formation, language use, thinking, understanding, problem solving, attention and memory. Thus, the cognitive approach is concerned with the individual's inner psychological functioning. Cognitive theorists have investigated and shown that people learn by perceiving, comprehending and conceptualising the problem. The comprehension of concepts and rules, *etc.*, is transferable to the solution of new problems. The cognitive theorists argue that people grasp things as a whole, and therefore, oppose the Behaviourist approach to teaching which employed drills to memorise the information. They believe, learning is both a question of ‘insight’ formation and successful problem solving, and not a mechanical sequence of stimuli and responses. Thus, teaching according to cognitivists, should encourage understanding based on ‘problem solving’ and ‘insight formation’.

Information Processing

The contemporary cognitivists equate human mental activities with the process that goes on in a ‘computer’ in operation. They conceptualise human beings as information processing system. The information processing system describes a psychological activity in terms of information being received by the senses and then information items being selected and passed on to short-term memory where encoding processes transfer them to the long-term memory. Long term memory provides a store room where information can be retrieved in order to make a response.

There are a number of elements, which are central to the cognitive theory of learning. To begin with, the individual is seen as one having active relationship with the environment. He has intentions and goals, and thinks of alternative strategies to achieve these goals. Thinking is essentially a purposive activity. Learning is, therefore, an intelligent and active process. Within this process, issues of perception are very important because perceptual activity is the first relationship between a person and his environment or situation. The individual interacts with the situation and this interaction leads to relativity in perception as he organises the stimulus into meaningful patterns. Thus an individual acquires knowledge through his interaction with the environment and stores it for using this in new situations.

ACTIVITIES THAT FACILITATE LEARNING

A classroom teacher performs a number of activities, which are aimed at facilitating learning.

These activities are:

- *Presenting the material*: The teacher present the prescribed materials, which are available in part or some other form. The teacher is supposed to breathe life into the text and help the learner communicate with it.
- *Identifying the objectives*: The syllabus and very often, the prescribed text itself make it clear as to what educational objectives are to be achieved through a particular course. But practically, it is the teacher who identifies them and states them in behavioural terms for the learner. It is the teacher who points to what is significant and what trivial, what needs more attention, and for what purpose.
- *Motivation and learner*: To reduce distraction, the teacher provides motivation. He brings learners to a state of readiness in which learning takes place more easily. All of us know of teachers whose very name or presence provides enough motivation for a successful teaching exercises. And then there are teachers who are demotivating in most of the situations.

- *Exploiting learner's experience*: Good teachers build on learners' experiences. One and the same concept may be brought home to rural learners with the help of their experiences and to those of urban learners with theirs.
- *Providing learning activities*: Once a new concept is taught or a new piece of information is given, the teacher promotes learning through learning activities. For example, after having taught formula, the teacher asks learners to apply their learning to work out the solution of a few problems.
- *Facilitating retention*: Just knowing about a concept, does not amount to having learnt it. The learner should be able to retain it in his memory. Good teachers use different ways and means to help their students to improve their retention through exercise.
- *Promoting transfer of learning*: Having learnt a concept or obtained any new learning, the learner should be able to transfer his learning to various issues within and across various disciplines. For example, if we have learnt about the notion of Relativity in physics, we should be able to think of a different kind of Relativity in sociology. Besides, transfer also means facilitating further learning. Used in either sense, transfer is provided by the teacher in the classroom through various means.
- *Providing occasion for feedback*: For successful teaching, two way feedback is needed from the learner to the teacher, and vice versa. The teacher provides occasion for this exchange. For example, he puts a few questions to see whether or not the learners have learnt what he taught.

It is worth noting that each individual learns as a result of his own efforts and successes. No teacher can learn anything for him.

The teacher's task is to understand and encourage the child, to watch for an appropriate psychological moment when he has a high degree of readiness to learn a specific task, to guide him into making a response, and then to reinforce his natural satisfaction in his own success. The learning that occurs in a child through experiences provided by the teacher starts from what he has previously learnt and moves in directions that are determined by the needs and interests he feels at the particular moment.

A teacher is effective if he is able to identify the child's own purposes and feelings of need. It is through the identification of these keys, the teacher unlocks the doors of learning in any direction that the child can see as significant for the satisfaction of his own purposes and needs.

PROGRAMMED LEARNING

Programmed Learning or Programmed Instruction is a learning methodology or technique first proposed by the behaviourist B. F. Skinner in 1958. The purpose of programmed learning is to "manage human learning under controlled conditions".

Programmed learning has three elements:

1. It delivers information in small bites,
2. It is self-paced by the learner, and
3. It provides immediate feedback, both positive and negative, to the learner.

It was popular in the late 1960s and through the 1970s, but pedagogical interest was lost in the early 1980s as it was difficult to implement and its limitations were not well understood by practitioners. It was revived in the 1990s in the computerised Integrated Learning System (ILS) approach, primarily in the business and managerial context. Programmed learning remains popular in self-teaching textbooks.

The methodology involves self-administered and self-paced learning, in which the student is presented with information in small steps often referred to as "frames". Each frame contains a small segment of the information to be learned, and a question which the student must answer. After each frame the student uncovers, or is directed to, additional information based on an incorrect answer, or positive feedback for a correct answer.

CRITICISM

Programmed Instruction has been criticised for its inability to provide adequate feedback on incorrect answers and for its lack of student instigated conceptualisation opportunities. It works best in basic courses which introduce the vocabulary of a discipline, heavily fact-based courses, and rule-based technical courses.

SIMULATED TEACHING

Normal experiential learning that leads to an expert professional in clinical practice is associated with prolonged exposure to that practice. The over-riding idea is that by simulating clinical scenarios, learning is accelerated by the debriefing/feedback session. The expert knowledge is made explicit to the trainee and reinforced with video and verbal feedback.

Simulation training can:

- Prepare students to cope with future roles.
- Provide practice in a safe environment with no risk to patient or student.
- Test/challenge trainee's technical and decision-making skills during realistic patient care situations.
- Be an assessment tool.
- Lead to standardised teaching.

Skills that can be assessed/practiced using simulation:

- Interpersonal and communication skills.
- Critical thinking and decision-making skills.
- Practical skills.
- The use of equipment.

The Best evidence medical education (BEME) collaboration is an international group of individuals, Universities and organisations committed to the promotion of best evidence medical education. They formed a topic group in 2002 that addressed the question: "What are the features/aspects of high fidelity simulators that lead to most effective learning?"

FEEDBACK

The absence of learner feedback was the greatest single factor for ineffective simulation training.

The lack of feedback could lead to:

- Learning of the wrong learning objective.
- Not realising what the desired behaviours should be by not focusing on them.
- Not transferring skills to clinical practice.
- Spending increasing time on only one aspect of training.

PRACTICE

A lack of opportunity for practice is also associated with a poor educational outcome. This could often be attributed to insufficient access to the simulator, as training sessions are usually time dependent, and the simulator is often a hotly contested resource. In addition, each learner is different, and some learners inevitably need longer or more frequent sessions with the simulator to achieve the same educational results as their co-learners.

VALIDITY

Poor validity is associated with a lack of realism. In some simulators novices can out-perform an expert, which questions the validity of that simulation. Typically, this would also lead to a lack of correlation with other outcome measures.

FIDELITY

A common belief is that low fidelity simulation is better than high fidelity. However the group concluded that all levels of fidelity should be used based on the required outcomes. This is discussed by Maran and Glavin, where the progression from low to high fidelity simulation is compared to the progression through medical education. Their conclusion is that the range of fidelity available is almost all potentially useful, but that many simulators are underused due simply to a lack of clear educational goals.

'SIMULATOR' LEARNING

Students learn to master the simulator rather than the task. The solution to this is to have multiple outcome measures for the task.

ASSESSMENT

There is current controversy about the use of simulators in high stakes examinations. Issues of domain specificity and itemised versus global scoring systems have bee raised. There is ongoing research into all of these factors though, and it seems certain that simulation will be included as part of high stakes assessment, along with other outcome measures.

IN SUMMARY

If you are thinking of using simulation in teaching you have to think:

- Who am I teaching?
- What am I teaching them?
- What are they expected to learn?

The simulation scenarios should:

- Be as realistic an environment as possible.
- Should involve feedback/debriefing/video sessions.
- Well prepared with a back up plan for equipment failure.
- Involve the observers by getting to make notes on teamwork, situation awareness, communication, *etc.*

Remember to create a relaxed teaching environment, as simulation can be a stressful experience for students. There follows a brief description of the reasons why simulation has become more popular as a teaching and assessment tool.

MEDICAL SIMULATION

The first recorded use of a medical simulator is that of a manikin created in the 17 Century by a Dr. Gregoire of Paris. He used a pelvis with skin stretched across it to simulate an abdomen, and with the help of a dead fetus explained assisted and complicated deliveries to midwives.

In spite of this early start, medical simulators had not really gained widespread use in the following centuries, principally for reasons of cost, reluctance to adopting new teaching methods, and scepticism that what was learned from a simulator could not be transferred to actual practice.

All of these reasons are still relevant today, however the combination of improved technology and increased pressures on educators have promoted simulation as one option to address the following problems with traditional clinical skills teaching.

An Alternative to "see one, do One"

In the past, health care professionals learnt on the job, which some still believe is the best way to gain experience. However, there are a number of barriers to this type of traditional clinical teaching.

These include:

- Humanitarian issues – practicing on patients is not ethical. We have moved into an age of where learning on patients is not acceptable if there is an alternative.
- There has been a decrease in the number of inpatients. In part due to an increasing number of day case patients and also the fact that chronic

conditions are being cared for in the community. This has led to a decrease in exposure and access of the trainees to ward patients.

- The training time for postgraduate medical education has decreased and will decrease further. With the implementation of new training schemes, experience cannot be built upon over time as before.
- Some situations are so rare that to gain experience would take many lifetimes.
- Legal/litigation issues. The possibility of educational establishments being sued by patients and ex-students for not teaching and assessing clinical skills as laid down by the regulatory bodies could arise.
- Record keeping, reproducibility, assessment and validity are issues all brought to the forefront with clinical governance and revalidation. Simulation is seen as away of addressing some of these issues.
- Students learn more effectively in a non-threatening environment.
- There is increasing emphasis on multidisciplinary learning, and clinical skills' teaching is an ideal forum for this.
- The increase in workload for health care staff means there is less time to spend on traditional clinical teaching, which is compounded by the increase in student numbers.

Recent Recommendations

Simulation training extends from part task trainers, procedural training to the experience of full clinical situations. For example canulation, basic and advanced life support to high fidelity simulators.

However, they also include communication skills, how to take consent, bereavement counseling and IT skills. In 'Tomorrow's doctors: Recommendations on undergraduate medical education.'

GMC July 2002, there are lists of clinical skills that medical students have to be competent in before graduation:

- "The essential skill that graduates need must be gained under supervision. Medical schools must assess students' competence in these skills. The curriculum must stress the importance of communication skills and the other essential skills of medical practice."

In 'Unfinished Business: Proposals for reform of the Senior House Officer grade.' A report by Sir Liam Donaldson, Chief Medical Officer for England, proposed changes in junior doctor training which were considerable.

With a shortened training period and the probable division of service commitment from effective training time, the provision of effective skills training and competency-based assessment will have to be addressed.

- "An objective of the foundation programme would be to develop and enhance core or generic clinical skills essential for all doctors (*e.g.*, team-working, communication, ability to produce high standards of clinical governance and patient safety, expertise in accessing, appraising and using evidence as well as time management skills.)"

Multidisciplinary Teaching

As well as increased emphasis on clinical skill teaching, there is increased emphasis on the multidisciplinary approach to learning. Of interest during multidisciplinary teaching are human factors such as decision-making and behavioural interaction, which is thought to be of major importance in the occurrence of critical incidents.

As quoted in 'Working Together – learning Together' A Framework for Lifelong Learning for the NHS. DoH, November 2001:

- "We are taking forward work to develop more pre-registration inter professional education programmes which incorporate common learning in core skills and knowledge. As a minimum we intend to ensure that all health professionals should expect their education and training to include common learning with other professions."

This emphasises that predetermined health care groups deliver many of the skills required by patients during their care, however in the future who delivers these skills may well change. It is envisaged that simulation teaching could provide packages that any group could access and interact with other groups for relevant multidisciplinary situations.

21ST CENTURY TEACHING AND LEARNING

There are two important questions that higher education must address while creating its future:

1. How to respond to dramatic changes in the profile of the student body; and
2. How to educate effectively the diverse student body.

New institutional structures need to have much greater flexibility and efficiency. Faculty will become designers of learning environments.

In Marcy's words:

- Faculty members will no longer be the sole conveyers of course content, as the environments in which students learn will expand. This will place added importance on the faculty's role in assuring the intellectual rigour of academic outcomes and in tying out-of-classroom experiences to intellectual constructs. It is important for faculty to spend less time in the current activities of lecture and test so that they will have time for the new work needed in mentoring and in developing and assessing quality learning environments. The ideal of the complete scholar will remain a reasonable expectation for faculty; yet, our understanding of the nature of teaching has begun to change.

Experts predict that most of the jobs that will exist in ten years do not exist today and that most of those new jobs will require education past the high school level. With this rapidly changing market, it is unreasonable to assume that workers can be trained once for lifelong jobs. Instead of holding a single job for 40 years, today's high school or college graduate is likely to change jobs several times. Those people who do keep the same jobs will have to deal with unprecedented change. Therefore, in the information age, “Learning must be a *lifelong process*. To prepare students for a lifetime of learning, schools must teach students more than facts; they must make sure students learn how to think and learn”, and the student-centered learning can be encouraged.

The student-centered learning environment shifts the instructor’s role from the source of all knowledge to a guide in the learning environment where they learn and work together. Chute, Thompson, and Hancock summarizes a comparison of 20th and 21st century workplace learning environments as presented in Example 1. Specifically, in Chute, Thompson, and Hancock’s words:

- Increasingly, learning activities can be customised and individually paced to serve a variety of learner needs. In this environment, the learner can be less of a listener and more of a collaborator in the learning experience. Technologies that support collaborative work by geographically separated participants will allow team learning, with the learners and instructors sharing responsibility for structuring and maintaining the learning process. As learners gain more experience and confidence in this type of learning environment, the instructor can increasingly fill the role of “guide on the side” rather than “sage on the stage.”

The study based on the data from preservice teachers has revealed that IT training is essential because it reduces the differences among participants with differing levels of competency with regard to attitudes. The magnitude of their strong dislike towards IT was greatly reduced after the IT training in the areas of word processing, spreadsheet use, database management, presentation software use, Web browsing, and telecommunication use.

The increasing importance of the new information and communications technology in all aspects of university activity (teaching, training, learning, research, and service to society) leads to a need for a fundamental rethinking of the educational process, the role of individualized and interactive learning, face-toface contacts, and teamwork. At the same time, face-to-face relationships are still vital but there is a new challenge to provide a rich range of opportunities that facilitate open-ended learning and thinking processes.

Ginkel describes the university of the 21st century in the following terms:

- During the 1990s, a typical theme of a conference on the role of the university was "the university of tomorrow." Now, however, tomorrow has arrived, and universities are undergoing very powerful stimuli to transform themselves. The principal driving forces are the development of knowledge societies and economies, the all-pervasiveness of the information technologies, globalization, and the debate on public or private education. These forces generate myriad responses that, while defying the elaboration of blueprints, call for constant change and diversity.

In the past decade since the release of the first Web browser (navigable windows into the Web), IT has implemented itself into virtually every corner of higher education: colleges use databases, networks, and a dizzying array of software to maintain academic and financial records, recruit new students, communicate with current students; enable professors to collaborate on research, disseminate library materials, and teach, whether in a classroom or as distance education.

The ten challenges that will face academe in the next decade include:

- Collaboration (faculty and staff instant messages, concurrently view and revise papers for publication, share instrument data, and hold videoconferences); and
- Wireless networks (As colleges extend their wireless coverage, more students carry laptops, and any question that crosses a student's mind or any conversation that could be helped by having more information produces the response.)

Technology has become ubiquitous as a tool for teachers and students, especially in such areas as organization, note-taking, writing, academic productivity, access to reference and general educational materials, and cognitive assistance. Reigeluth believes that teaching methods might shift from decontexualized learning to authentic tasks, proposing the principles that characterize the new paradigm of education.

A book titled *Learner-Centered Teaching* by Weimer applies to the college and university classroom. This book offers the five key concepts to practice in higher education, focusing on the teaching and learning curriculum objectives rather than the content-delivery-based focus such as Weimer's own teaching experiences:

- As I thought about the beginning communication course I was to teach, it seemed to me that what prevented students from doing well was a lack of confidence. They needed to find their way past self-doubt, awkwardness, and the fear of failure or a place where they could ask a question in class, make a contribution in a group, and speak coherently in front of peers. It came to me that I might address the problem by making the students feel more in control…. I tried this approach…students were committed to the class; they appeared genuinely interested in the content. They asked more questions, sustained discussion longer…. It was not instructional nirvana, but it was a decided improvement, and I was motivated to continue refining this approach.

We should recognize that neither IT nor educational settings are the direct cause of the changes we are experiencing; nevertheless:

- Without new information and communication technologies, none of what is changing our lives would be possible. In the 1990s, the entire planet is organized around telecommunicated networks of computers at the heart of information systems and communication processes…. Technology *per se* does not solve social problems. But the availability and use of information and communication technologies are a prerequisite for economic and social development in our world…. In sum, globalization is a new historical reality.

It may be that information and knowledge have always been essential factors in power and production. To invest in education is a productive investment; an educated labour force is a source of productivity. An educated populace is a vital resource for national growth and development in a global economy, and an important mission of higher education is to assist students in participating in the global economy.

Bill Gates put it: "In all areas of the curriculum, teachers must teach an information-based enquiry process to meet the demands of the information age. Meeting this challenge will be impossible unless educators are willing to join the revolution and embrace the new technology tools available."

Higher education must be the leader in the use of new technologies. The modern mission of higher education increasingly focuses on effective teaching and learning related to occupational training for students, in addition to the intellectual development of the students. Higher education faculties are responsible for preparing tomorrow's teachers, as well.

DIVERSITY, BILINGUALISM, AND TECHNOLOGY

The following are some perspectives concerning diversity, bilingualism, and technology:

- *Libraries*: Based on the notion that libraries are all about *choice*s, Parry provides a discussion as to
  - The role of audiovisual materials in increasing circulation and library visits,
  - The effect of format proliferation in radically changing the depth and diversity of a collection, and
  - What public libraries can do to meet the challenges of offering format choice while maintaining quality of the collection.
- *University Deans*: Universities expect deans to lead their colleges based on six strategies:
  - Create a diverse culture,
  - Know the legal environment,
  - Become technologically connected,
  - Strategically manage and secure financial resources,
  - Seek and maintain professional and personal balance, and
  - Nurture the integrity of the college.
- *Counseling*: The profile of the typical community college student is different from that of the student of 40 years ago, and community colleges should recruit bilingual and bicultural counselors. *Effective instruction*: From the notion that all teachers can participate successfully in educational reform, it is natural for Calderon to believe that effective instruction in bilingual and multicultural schools requires that teachers combine a sophisticated knowledge of subject matter with a wide repertoire of state-of-the-art knowledge about learning theory, pedagogy, technology, and assessment.

- *Content Integration*: The goal of content integration is to expand the curriculum by incorporating contributions of diverse cultures into traditional disciplines of study through technology: e-mail and multimedia technologies promote communication and interactions between diverse groups with the purpose of helping students learn more about content they study in subject areas.
- *Mentoring*: New forms of work, technology, and learning are influencing the practice of mentoring. Organizational trends such as downsizing, restructuring, teamwork, increased diversity, and individual responsibility for career development are contributing to a resurgent interest in mentoring in the 1990s; telementoring through the Internet is emerging as a way to pair teachers and learners with subject matter experts who can provide guidance and feedback on learning projects.
- *Digital Divide*: Computers and the Internet are becoming increasingly important for full participation in life and are revolutionizing the ways people learn, communicate, and earn a living. Thus the digital divide (the separation between those with access to new technologies and those without) is seen as one of the leading equity issues in the United States.

DIVERSITY AND EDUCATIONAL TECHNOLOGY

- *Electronic Admission Process*: Students can use technology to receive advisement, register for classes, explore potential careers, and prepare assignments for classes. Hirt, Nurray, and McBee examined outcomes associated with the use of technology in the admissions process and found:
  - Women did not use technology to the same extent as men, and
  - The minority students were less likely to apply for admission electronically. The use of electronic admission systems could lead to a decrease in the number of female and minority applicants. The increased use of technology in the admission process, a seemingly positive objective with respect to technology, had unanticipated negative consequences for the university's goal of increasing diversity among students.
- *Diversity in Sciences*: From the perspective that technology is increasingly being driven by advances in the understanding of the life sciences rather than the physical sciences, Campbell urges that higher education, particularly in the sciences, is facing challenging questions as the various disciplines unfold, pointing out that one crucial issue is the inadequate success in developing the full potential of students in the sciences from all economic and ethnic backgrounds, that is, developing a more diverse cadre of students and to bring them into the natural sciences, mathematics, and engineering professions.

- *Technologies to Promote Equality and Cultural Diversity*: According to Merryfield, one of the critical failures of social studies teacher educators in the late 20th century has been the inability to prepare teachers who teach for educational equality, cultural diversity, and global interconnectedness. Merryfield focuses on the use of electronic pedagogy and its application within graduate courses in social studies and global education. Teachers in Merryfield's article have perceived the initial online postings of bios and threaded discussions as more purposeful than an oral class discussion because of the deliberate nature of reading and writing messages, even though teachers have to work on the online assignments late at night or very early in the morning. Online discourse is substantively different from face-to-face, especially on sensitive and controversial topics. Finally, "We need studies designed by researchers in both technology and multicultural and global education across many contexts to understand how electronic technologies can improve these aspects of social studies teaching and learning".
- *Evaluation of Web Forum*: Soest, Canon, and Grant discuss challenges that educators face in attempting to develop culturally competent social workers that understand the dynamics of oppression and embrace a commitment to promoting social justice. What students liked about the Web forum include: anonymity (because they feel safe); expression of sensitive issues (but discussions are open and frank); and time factor (provides an extended period of time for discussion). What students disliked about the forum include: negative nature of student comments (which are judgemental and disrespectful); patterns of participation (only a few people post regularly); and technical issues (setting up e-mail accounts, slow download times, and Internet phobia).
- *Limitations of Online Courses*: Marra and Jonassen examined the effects of distance learning pedagogy that emphasizes alternative forms of knowledge representation, and the use of distributed tools on student outcomes. The data from student performance in the K-12 education online programme revealed that learning outcomes are limited by the lack of pedagogical influences in the course delivery. This is because online courses do not support the use of alternative forms of knowledge representation by learners, authentic forms of assessment, and the use of distributed tools to scaffold different forms of reasoning. The range of student learning outcomes is restricted to reproductive learning.
- *Diversity Module*: Gabbard, L'Esperance, Perez, and Atkinson share the experience of the development of the Diversity Module for online delivery utilizing the Blackboard distance learning platform for teacher preparation. Blackboard allows instructors to place online students into small groups' discussion boards. Knowledge is improved when the learner takes control of his or her thinking

processes and skills. Curriculum, instruction, and assessment should be aligned to enhance the teaching of thinking. Diversity Module of the specific features of Blackboard enhances the advantages of lateral entry programmes. The first series of questions asks these lateral entry teachers to reflect on their own beliefs about students: What do I believe I know about my students' experiential backgrounds? How are these beliefs reflected in my teaching practices? And, do I hold different beliefs for students from various ethnic backgrounds and social strata?

IT AND EDUCATION IN THE ASIA-PACIFIC REGION

Educational Technology, the magazine for managers of change in education, has focused on online learning and IT in the Asia-Pacific region.

This issue covers the following countries:

- *Singapore*: According to Hung, Tan, and Chen, technology integration efforts in Singapore schools and at the National Institute of Education with the Ministry of Education, launched the IT Master Plan in 1997. Master Plan I focused on building up the physical and technological infrastructure in the schools; fostering teacher development in the use of IT; building up of content and learning resources; encouraging innovation, research, and development; infusing curriculum and assessment issues in and through IT; and establishing international relations and linkages with regard to IT. Master Plan II should be more specifically focused on learning processes and Web-based online learning.
- *Japan*: Fujitani, Bhattacharya, and Akahori report that Japan's Ministry of Education is now carrying out a project called "E-Japan Strategies," with the emphasis on educational use of ICT in schools. The Ministry has set a target of installing Internet connections in all classrooms by 2005-2006, and this new curriculum puts emphasis on utilizing ICT as a means, and its aim is that children are to be equipped to catch up with the latest knowledge and skills. In particular, the subject area of IT will focus not only on computer-literacy skills, but also on knowledge and morals in the era of the information age, along with judgement of values.
- *China*: According to Zhiting, Xiaoqing, and Qiyun, the Ministry of Education of China launched a national initiative, "The National Programme for Invigorating Education Towards the 21st Century," in 1998 for the ICT applications. Online higher education programmes are offered at three levels: undergraduate degrees, master's degrees, and special training diplomas. Two distance lecturing models are adopted in online higher education:
  1. A model in which an instructor gives a presentation on campus and is delivered to remote learning sites through a digital satellite or an interactive video conferencing system; and

2. A model in which presentations are prerecorded on CD-ROMs and then mailed to the remote learning sites or learners. The distance education includes online course resource construction for higher education, adult education, and basic education (*e.g.*, English language).

- Hong Kong: According to Lee and Lam, the government adopted a comprehensive four-pronged IT implementation strategy in 1998:
  1. Access and connectivity (to provide financial support to schools for setting up a connectivity infrastructure);
  2. Teacher ennoblement (to set teacher IT competence);
  3. Curriculum and resource support (to develop software to facilitate IT usage in teaching and learning); and
  4. Community-wide culture (to involve stakeholders in helping implement IT in education). The IT development should now be directed towards online learning. WebQuest and ThinkQuest are examples of the type of teaching formulated. This learning characterizes the paradigm shift from teacher-centered to student-centered.
- *Australia*: As noted by Taylor (2003), to increase the accessibility of high-quality education in cost-effective ways, many Australian universities are linking the introduction of ICT to the notion of *student-centeredness* and referring to the emergent and convergent educational practices as *flexible learning,* characterized as follows:
  – Decreasing reliance on face-to-face teaching;
  – Increasing reliance on student self-management and independence; and
  – Increasing reliance on ICT, particularly the use of the Internet, in teaching and learning. The empirical research on the convergence of two technologies (the traditional technology of the university campus; and the emergent technology of online, flexible learning) conducted at the Logan Campus of Griffith University. The results showed that 66% of the students (N = 463) believe that the flexible learning approaches (with the Internet) are more effective than traditional teaching methods. The results are consistent with those of prior studies, yet this is only one case study.
- *Taiwan*: According to Liaw, in Taiwan, the most popular educational Internet programme, TANet (Taiwan Academic Network), was established to support an IT infrastructure for all schools and research organizations. TANet not only provides collaborative opportunities for research, but also shares network resources for teaching and learning, applying for the following perspectives: *courseware-oriented direction* (courseware refers to tools that support instructional design, delivery, and management of online courses); *theory-oriented direction* (online

learners can learn actively by constructing new knowledge based on prior knowledge); *instruction-oriented direction* (to create a successful learning environment for students); and *community-oriented direction* (this multiuser network provides enormous potential for collaborative learning). Since Taiwan's educational culture is different from that of the western world, it is crucial to develop an indigenous learning theory for Taiwan's online learners.

- *South Korea*: According to Jung, in the 1990s, South Korea focused on an "Edutopia" (an education welfare state), a society of open and lifelong education to allow each and every individual equal access to education at any time and place. An important initiative by the government for the adult learning system was the creation in 1997 of a Cyber Teacher Training Center for in-service teacher training. In 1998, the government established the two-year Virtual University Trial Project to create a cost effective virtual education system without diminishing quality. More than 100 conventional higher education institutions have introduced Internetbased virtual courses into their curriculums, (*e.g.*, Ewha Woman's University has offered virtual education programmes.) Flexible, effective, and efficient distance education for adult learners should be developed through ICT, which is changing the nature of learning.
- *New Zealand*: According to Kinshuk, Massey University has multiple campuses situated in different parts of New Zealand, with about 60% of its students off campus and 40% studying on campus or internally. The university has purchased a site license for the WebCT learning management system, which remains its primary system. Embracing online learning at all levels, the University has entered into the process of becoming a global provider of education, enhancing the learning experience of on-campus and off-campus students alike.

In summary, the government of Singapore has invested to establish IT infrastructures and resources in schools in such areas as cyber conferencing, e-learning service providers, and wireless technology. Japan's Ministry of Education is now carrying out a project, "E-Japan Strategies," with the emphasis on ICT in schools. The Ministry of Education of China launched a national initiative, "The National Programme for Invigorating Education Towards the 21st Century." In Hong Kong, the government adopted a comprehensive four-pronged IT implementation strategy.

Many Australian universities are linking the introduction of ICT to the notion of student-centeredness and referring to the emergent and convergent educational practices as "flexible learning." In Taiwan, the most popular educational Internet programme, TANet (Taiwan Academic Network), was established to support an IT infrastructure for all schools. South Korea has focused on the fulfilment of the public need for higher education and lifelong learning. Finally, Massey University in New Zealand has entered into the process of becoming a global provider of education, enhancing the learning experience of on-campus and distance learning students alike. In addition, as noted by Ziguras (2001), educational commentators in South East Asia are increasingly promoting the use of educational technology as a way of enhancing the creativity and inventiveness of students. In Singapore and Malaysia, these qualities are seen as essential to future national economic development. In these countries, there is a clear vision of an emergent form of educational delivery that is challenging existing educational traditions. The Singaporean and Malaysian governments see educational technologies as a means to encourage greater self-direction and creativity on the part of students.

Ziguras points out, however, that the rapid growth of technology has led to renewed concerns about cultural impacts: the implicit social values of the exporting countries will inform curriculum, and the social and cultural context in which students live will be largely ignored. Ziguras believes that if education is conceived as a way of changing students, then educators should accept that they cannot be culturally benign, but invariably promote certain ways of being over others, and that educators need to be aware of their role in social change and be able to justify to themselves the role they play.

HUMAN LEARNING AND COGNITION

Cognitive psychology has replaced behaviourism as the dominant school of thought in American psychology. What brought about this cognitive revolution? Why were the early leading advocators of human information processing dissatisfied with behaviourism? Which of behaviourism's assumptions did HIP researchers reject? What evidence and arguments were used against behaviourism? Why did both behaviourists and HIP researchers reject the notion of stages? HIP brands of cognitive psychology take a different view of development than do Piagetians.

This section discusses the following:

- Cognitive revolution in American psychology
- The HIP approach
- Methods of behaviourists and HIP theorists
- Piagetians versus the HIP approach
- Knowledge versus mind
- The rejection of the stage theory

COGNITIVE REVOLUTION IN AMERICAN PSYCHOLOGY

The terms *behaviourism* and *learning theory* were used as if they were synonymous for many years in American psychology. This is because early psychologists assumed that people think, have ideas and sensations, and act through the power of free will. As the psychologists observed it, their task was to catalogue the nature of these ideas and sensations using introspection as a tool. Introspection became something of an art, particularly when Wilhelm Wundt, often regarded as the founding father of modern psychology, trained people to look inside themselves and to report their internal experiences as they thought, perceived, and learned. John B. Watson, the father of behaviourism, was a vocal opponent to the use of introspection.

Watson argued that the field of psychology should concentrate its efforts on the study of behaviour and leave the understanding of the internal mental states. With regard to human learning, Watson asserted that the observable events would be physical stimuli, which give rise to overt response. Eventually, from about 1910 to 1950, behaviourism dominated scientific psychology in the United States. After that, the attempt to understand behaviour in terms of mental processes was replaced by explanations in terms of laws of learning, which concentrated on the functional relations between environmental stimuli and behavioural responses.

As Watson's behaviourism was his reaction to the earlier mentalism, so cognitive psychologists felt that the time had come to look more closely at internal events that were completely rejected by behaviourists. Piaget, in particular, argued that human subjects are not just passive receivers of stimuli and producers of responses. Piaget further argued that learning is an *active process* that involves the use of strategies and the transformation of sensory experiences into new categories and organized conceptions. The term *cognition* began to receive wider use throughout experimental psychology and came to be used as a general term to describe the mental process.

Human learning, engaging in active responding, organizing, and recognizing materials almost always involves some kind of cognitive activity. Behaviourism rejected the subjective study of mental phenomena to make psychology a science and to equip it with the tools of objectivity and measurement. Similarly, cognitive psychology later rejected the narrowness of the stimulus-response view of behaviourism regarding human activities, setting as its goal a scientific study of behaviour. Cognitive psychologists hope to understand and to explain the internal mental states that lie just between the stimulus and the response.

THE HIP APPROACH

Cognitive revolution occurred in American psychology during the 1950s and 1960s. The most salient features of this new approach to psychology at that time were the acceptance of *mental processes* and the representation of knowledge as necessary components in understanding human learning and the rejection of the narrow approach by behaviourists. Two major forces have shaped modern theories of cognitive development. The first force is the work and ideas of Jean Piaget of Switzerland, who was much influenced by B. T. Baldwin, the first major modern developmental theorist. The second force is the HIP approach, which was not the product of any particular person. Barasalou recognizes computer science as the third major force that has contributed to the demise of behaviourism and the rise of cognitivism, describing that the components of cognitive theory are similar to computer components, as is their organization. In other words, the central theme that unites cognitive psychology and computer science is information processing; both disciplines focus on how systems acquire, store, retrieve, transform, and produce information to perform intelligent activities.

Humans are Limited Information Processors

In one sense, this is correct. Information processing, whether in humans or in machines, involves two separate domains: hardware and software. In psychobiology, the functioning of *hardware* means the physical interconnections of neurons and intraneuronal affected by learning. *Software* refers to the ways in which data are referenced, accessed, and manipulated. Because humans cannot process a vast amount of data to produce information quickly, completely, and accurately, they are called *limited information processors*. Humans, however, are *active* processors of information, whose memory banks differ from those in computers.

Information is stored for a short time in short-term memory and then is rehearsed and encoded for storage in long-term memory. Memory goes through a process of reconstruction from the abstracted cues that are remembered. Information is stored precisely in a computer, whereas human memory is less precise but colourful or informative. Humans process many items at the same time, whereas computers do one thing at a time.

John Flavell, a developmental psychologist, and Noam Chomsky, a linguist, should be named definitely. Why were they dissatisfied with behaviourism? The major reason for their dissatisfaction was that behaviourists did not share common views on what was learned, how it was learned, or what class of theoretical conceptions was most appropriate to account for human learning. How does a child learn to think about the world, to use mathematical reasoning, and to master the syntactic structure of language? In order to answer these questions, it is necessary to explain what is developing and how development occurs.

Behaviourism's Assumptions

First, it is important to remember the belief of Watson: learned associations between external stimuli and observable responses are the building blocks of human development. Behaviourists clearly express a mechanistic worldview, focusing on the way in which the stimulus-response relationship is formed. They view learning as changes in the form or the frequency of behaviour as the consequence of environmental events. HIP researchers reject this assumption. Instead they argue that learning is an internal mental activity that cannot be observed directly, pointing out that the behavioural view of learning conclusively differs from the cognitive view of learning as an acquisition of knowledge and cognitive structures due to information processing.

Second, we should emphasize that traditionally behaviourists have characterized the organism as a *tabula rasa*, whose behavioural habits and skills primarily reflect the particular environmental events that occur in conjunction with behaviour. B. F. Skinner, one of the most influential American psychologists, stresses that the essence of human development is the continual acquisition of new habits of behaviour and that the learned behaviour is controlled by external stimuli. HIP rejects this assumption and argues that learning results from interaction between an environmental stimulus and a learner. When Skinner tried to explain language learning from a behaviourist's perspective, for example, Chomsky urged that Skinner's view only considered the observable stimuli and responses in linguistic interactions and was not sufficient to account for the structural properties of human utterances.

MODELS OF BEHAVIOURISTS AND HIP THEORISTS

Behaviourists use operant conditioning. Skinner has stated that human behaviour is the most familiar feature of the world. Skinner advanced Watson's behavioural perspective by demonstrating and then by gaining understanding of one very important form of learning called "operant conditioning."

Operant Conditioning

Operant conditioning is defined as a learning theory or model in which voluntary behaviours are strengthened or weakened by consequences or antecedents. Classical Conditioning by Ivan Pavlov, a Russian physiologist and psychologist, emphasizes the relationship between antecedent stimuli and responses, while operant conditioning emphasizes the relationship between responses and their consequences. All the basic principles of Pavlovian conditioning are found in Skinner's experiment: a rat learned to press the bar more often when the behaviour was reinforced by a food pellet. Similarly, a child tends to repeat behaviour that has pleasant consequences and to cut down on behaviour that has unpleasant consequences.

Operant conditioning pair behaviours with consequences, which are only effective if they increase desired behaviour or decrease undesired behaviour. If the consequence weakens the behaviour, then it is called punishment. In the behavioural view, consequences determine to a great extent whether a child will repeat the behaviour that leads to the consequences. Reinforcers are consequences that strengthen the associated behaviour.

There are two types of reinforcement:

- *Positive* reinforcement, which occurs when the behaviour produces a new stimulus; and
- *Negative* reinforcement.

The word *negative* in negative reinforcement does not imply that the behaviour being reinforcement is necessarily negative which means something similar to something that is subtracted.

Associate positive or negative reinforcement occurs by adding or subtracting something following a behaviour. Negative reinforcement is often confused with punishment. A behaviour followed by a punishment is less likely to be repeated in similar situations in the future.

In Kimball's words:

- Through painstaking research, Skinner accumulated significant, if counterintuitive, evidence that behaviour is changed less by the stimuli that precede it (though context is important) and more by the consequences that immediately follow it (*i.e.*, consequences that are contingent upon it).

In the field of special education, behaviour analysis exists on three interrelated levels:

- *Technology* (suspension bridges, and incidental teaching);
- *Science* (physics, engineering, and applied behaviour analysis); and
- *Philosophy,* for instance, Skinner's description of the three-term contingency (*i.e.*, cause-precedes-effect reasoning) as the "atom" of behaviour from which effective instructional technology and cohesive theories of autism intervention have been build.

Cognitive Model

HIP theorists use a cognitive model, which is a model of information processing of learning. One of the central metaphors of the information age is that the "human mind is a computer." In particular, computer science and artificial intelligence caused the reexamination of basic postulates of memory processing and storage, as well as of language processing and acquisition. HIP theories search for the ways the human mind *acquires*, *stores*, *recalls*, and *uses* information. These functions are very similar to the functions of computers.

A poplar model of HIP does visualize three memory storages and a set of processes that determine whether and how stimuli undergo further processing. The memory system is an example of a high-level component of the HIP theory. A second characteristic of the HIP theory is an emphasis on the codes or representations used to store information.

The first memory storage is the sensory register, which holds stimuli briefly (about one to three seconds) in original form for possible future processing. The short-term memory is the second memory storage (also called *working memory*), which holds about seven bits of information for about twenty seconds. The long-term memory is the third memory storage (also called the *permanent store house of information*), which is thought to have an essentially unlimited capacity. Because of the limitations of the sensory register and short-term memory, some information may be lost at each point of entry.

- *Sensory register:* Sensory register is the entry point to the memory system. Children seem to be somewhat slower than adults in forming a sensory representation of what they see; this slower speed of taking in information may restrict learning and memory for children. The process of recognition involves noting key features of a stimulus and relating them to already stored information. The most important point to remember is the recognition and meaningful processing of information. The selective focusing on a portion of the information currently stored in the sensory register is what is called "attention," and there are individual differences in attention.

- *Short-term memory:* The next source of development is short-term memory. Two of the most well established principles of human memory are *rehearsal* and *organization*. Rehearsal refers to the continuous repetition of what one is trying to hold in mind; elaborative rehearsal is based on organization (several items are grouped together on some basis and rehearsed as a set) and meaningfulness. Older children and adults are more likely to rehearse several items and to adapt rehearsal strategies to the particular domains of the task. Young children are less likely to divide a list according to stable and helpful categories, or to search categories systematically.
- *Long-term memory:* The long-term memory does play an influential role throughout the information processing system. Stored knowledge in the long-term memory is believed to be organized in schemata, which are related to Piaget's scheme. When schemata are well formed, comprehension occurs. When schemata are poorly structured or absent, on the other hand, learning is slow and uncertain. We should emphasize that both the long-term memory storage and meaningfulness can be enhanced by relating what is to be learned to what is familiar to the child.

Behaviourists vs. HIP (Topics of Interest)

Behavioural theorists believe that cognitive processes (such as thinking and sensing) are behavioural; whereas, HIP theorists believe that cognitive process is the base of behaviour. Behaviourists assume that the outcome of learning is change in behaviour, emphasizing the effects of external events on the individual. Human subjects actively operate on their environment to produce different kinds of consequences. Behaviour modification therapy is based on the principle that behaviour is learned and, therefore, it is possible to change almost any behaviour by altering the individual's environment. Cognitive psychology, on the other hand, is concerned with how human subjects acquire, transform, represent, store, and retrieve knowledge, and with how the knowledge directs what they attend to and how they respond. HIP's interest is brain-processing, focusing on the following topics: attention, memory, pattern recognition, semantic organization, images, language process, thinking, judgement, reasoning, remembering, creating, and solving problems, as well as other cognitive topics that have been once considered outside the boundary of experimental psychology.

How does the brain spontaneously process information? Using top-down processing while driving down the road, the sequence of information processing can be cited as follows:

- *If…* what you see in the road ahead is a puddle of water (puddle hypothesis),
- *And…* you continue driving towards it (proposed test),

- *Then…* your tires should splash through the puddle and they should get wet (predicted result),
- *But…* upon reaching the puddle (actual test), it disappears and your tires do not get wet (observed result),
- *Therefore…* the puddle hypothesis is not supported; what you saw was probably not a puddle of water (conclusion). Perhaps it was a mirage, and so on.

As Hall emphasizes, "this top-down hypothetico-deductive process takes place very rapidly and subconsciously; and one does not necessarily know that this is how their brain works".

PIAGETIANS VS. THE HIP APPROACH

PIAGET'S STAGE THEORY

HIP brands of cognitive psychology take a different view of development than do Piagetians. Piaget presents his stage theory of development described in the following:

- *Sensorimotor stage:* The first stage lasts from birth until about two years of age. Infants and children during this stage lack true thoughts and acquire understanding primarily through sensory impressions and motor activities, and move from having only innate reflexes at the beginning to being able to mentally represent the external world. A cognitive development milestone (object permanence) occurs between the four- and eight-montholds. Children under the age of two tend to imitate the behaviour of people or animals. These imitative behaviours show their increasing ability to think in terms of symbols. Alos, schemata develop into mental representations when children during this stage begin to store information about the world and use that information as the basis for later behaviour. Keeping Maria Montessori's thought (the hand is the tool of the intellect) in mind, Orion has noted the importance of development of the human hand in the first three years of life based on her own observation that the Japanese children live in a culture where it is still very common for exquisitely beautiful things (such as *origami*) to be made by the hand and this is an advantage.
- *Preoperational stage:* This stage usually lasts from two until seven years of age. Many symbols are derived from mental imitation and involve both visual images and bodily sensations; the schemes of this stage incorporate and build on the schemes of the previous stage. Even though children's thinking is more sophisticated, they are still limited in their ability to use new symbol-oriented schemes, and their thinking and behaviour are illogical. In a typical conservation experiment, a child is asked to explain what happens when water is poured back and forth between containers of different sizes and shapes. The preoperational child is unable to consider more than one feature at a

time and is unable to mentally reverse the action of pouring; therefore, the child is likely to maintain that a tall container holds more water than a squat container, even if the amount is the same. When asked, "Why do you think so?" preoperational children tend to reply, "Because it's taller."

- *Concrete operational stage:* This stage normally lasts from 7 to 11 years of age. Schemes develop, which allow children a greater understanding of such logic-based tasks as conservation (matters are neither created nor destroyed, but simply change shape or form), class inclusion (constructing hierarchical relationships among related classes of items), and striations (arranging items in a particular order). Operational thinking is still limited to objects that are actually present or that children have experienced concretely and directly. Furthermore, if asked to deal with a hypothetical problem, concrete and operational children are likely to be stymied. Children at the age of seven are not likely to be able to solve abstract problems by engaging in mental explorations.
- *Formal operational stages:* This stage begins at eleven years of age. It is the stage in which children reach the point of being able to generalize and to engage in mental trial and error by thinking of hypotheses and testing them in their heads. The term "formal" reflects the ability to respond to the form of a problem rather than to its content and to form hypotheses. Children in this stage make a movement from an ability to think and reason about concrete visible events to an ability to think hypothetically. The cognitive structure of this stage is characterized by four rules for manipulating the content of thought: identity, negation, reciprocity, and correlativity. The formal, operational thinkers can read the analogies "10 is to 30 as 1 is to 3," and they are able to deal with abstractions, form hypotheses, and engage in mental manipulations. Formal operational thinkers are also able to understand and use complex language forms, such as proverbs, metaphors, and sarcasms.

"The sheer mass of Piaget's research into children's intellectual activity and the complexity of his framework caught the English-speaking educational world by surprise in the late 1950s". Concerning Piaget's view that children under the age of six and a half are unable to reverse their verbal thinking, children between 7 and 11 can if they use concrete materials, and children after 11 can think propositionally, Hall has further noted:

- The Piagetian notion of fixed stages, which set limits on children's use of logic, began to circulate alongside Susan Isaacs's view that children use reason from an early age and can raise questions, hypothesize and experiment when conditions stimulate their interest.

6

Pedagogical Perspectives in Designing Educational Technology

PEDAGOGICAL APPROACHES OR PERSPECTIVES

It is possible to use various pedagogical approaches for eLearning which include:

Instructional Design: the traditional pedagogy of instruction which is curriculum focused, and is developed by a centralized educating group or a single teacher.

Social-constructivist: this pedagogy is particularly well afforded by the use of discussion forums, blogs, wiki and on-line collaborative activities. It is a collaborative approach that opens educational content creation to a wider group including the students themselves. The One Laptop Per Child Foundation attempted to use a constructivist approach in its project

Laurillard's Conversational Model is also particularly relevant to eLearning, and Gilly Salmon's Five-Stage Model is a pedagogical approach to the use of discussion boards.

Cognitive perspective focuses on the cognitive processes involved in learning as well as how the brain works.

Emotional perspective focuses on the emotional aspects of learning, like motivation, engagement, fun, *etc.* Behavioural perspective focuses on the skills and behavioural outcomes of the learning process. Role-playing and application to on-the-job settings.

Contextual perspective focuses on the environmental and social aspects which can stimulate learning. Interaction with other people, collaborative discovery and the importance of peer support as well as pressure.

REUSABILITY, STANDARDS AND LEARNING OBJECTS

Much effort has been put into the technical reuse of electronically-based teaching materials and in particular creating or re-using Learning Objects.

These are self contained units that are properly tagged with keywords, or other metadata, and often stored in an XML file format. Creating a course requires putting together a sequence of learning objects. There are both proprietary and open, non-commercial and commercial, peer-reviewed repositories of learning objects such as the Merlot repository.

A common standard format for e-learning content is SCORM whilst other specifications allow for the transporting of "learning objects" (Schools Interoperability Framework) or categorizing metadata (LOM).

These standards themselves are early in the maturity process with the oldest being 8 years old. They are also relatively vertical specific: SIF is primarily pK-12, LOM is primarily Corp, Military and Higher Ed, and SCORM is primarily Military and Corp with some Higher Ed. PESC-the Post-Secondary Education Standards Council is also making headway in developing standards and learning objects for the Higher Ed space, while SIF is beginning to seriously turn towards Instructional and Curriculum learning objects.

In the US pK12 space there are a host of content standards that are critical as well-the NCES data standards are a prime example. Each state government's content standards and achievement benchmarks are critical metadata for linking e-learning objects in that space.

An excellent example of e-learning that relates to knowledge management and reusability is Navy E-Learning, which is available to Active Duty, Retired, or Disable Military members. This on-line tool provides certificate courses to enrich the user in various subjects related to military training and civilian skill sets. The e-learning system not only provides learning objectives, but also evaluates the progress of the student and credit can be earned towards higher learning institutions. This reuse is an excellent example of knowledge retention and the cyclical process of knowledge transfer and use of data and records.

TECHNOLOGY ISSUES

As early as 1993, Graziadei, W. D. described an online computer-delivered lecture, tutorial and assessment project using electronic Mail, two VAX Notes conferences and Gopher/Lynx together with several software programmes that allowed students and instructor to create a Virtual Instructional Classroom Environment in Science (VICES) in Research, Education, Service & Teaching (REST). In 1997 Graziadei, W.D., et al., published an article entitled "Building

Asynchronous and Synchronous Teaching-Learning Environments: Exploring a Course/Classroom Management System Solution". They described a process at the State University of New York (SUNY) of evaluating products and developing an overall strategy for technology-based course development and management in teaching-learning.

The product(s) had to be easy to use and maintain, portable, replicable, scalable, and immediately affordable, and they had to have a high probability of success with long-term cost-effectiveness. Today many technologies can be, and are, used in e-Learning, from blogs to collaborative software, ePortfolios, and virtual classrooms. Most eLearning situations use combinations of these techniques.

Along with the terms learning technology, instructional technology, and Educational Technology, the term is generally used to refer to the use of technology in learning in a much broader sense than the computer-based training or Computer Aided Instruction of the 1980s. It is also broader than the terms Online Learning or Online Education which generally refer to purely web-based learning. In cases where mobile technologies are used, the term M-learning has become more common.
E-learning, however, also has implications beyond just the technology and refers to the actual learning that takes place using these systems.

E-learning is naturally suited to distance learning and flexible learning, but can also be used in conjunction with face-to-face teaching, in which case the term Blended learning is commonly used. E-Learning pioneer Bernard Luskin argues that the "E" must be understood to have broad meaning if e-Learning is to be effective. Luskin says that the "e" should be interpreted to mean exciting, energetic, enthusiastic, emotional, extended, excellent, and educational in addition to "electronic" that is a traditional national interpretation. This broader interpretation allows for 21st century applications and brings learning and media psychology into the equation.

In higher education especially, the increasing tendency is to create a Virtual Learning Environment (VLE) (which is sometimes combined with a Management Information System (MIS) to create a Managed Learning Environment) in which all aspects of a course are handled through a consistent user interface standard throughout the institution. A growing number of physical universities, as well as newer online-only colleges, have begun to offer a select set of academic degree and certificate programmes via the Internet at a wide range of levels and in a wide range of disciplines. While some programmes require students to attend some campus classes or orientations, many are delivered completely online. In addition, several universities offer online student support services, such as online advising and registration, e-counseling, online textbook purchase, student governments and student newspapers.

e-Learning can also refer to educational web sites such as those offering learning scenarios, worksheets and interactive exercises for children. The term is also used extensively in the business sector where it generally refers to cost-effective online training. The recent trend in the e-Learning sector is screencasting. There are many screencasting tools available but the latest buzz is all about the web based screencasting tools which allow the users to create screencasts directly from their browser and make the video available online so that the viewers can stream the video directly. The advantage of such tools is that it gives the presenter the ability to show his ideas and flow of thoughts rather than simply explain them, which may be more confusing when delivered via simple text instructions. With the combination of video and audio, the expert can mimic the one on one experience of the classroom and deliver clear, complete instructions. From the learners point of view this provides the ability to pause and rewind and gives the learner the advantage to move at their own pace, something a classroom cannot always offer. One such example of e-Learning platform based on screencasts is Yo Help Online.

COMMUNICATION TECHNOLOGIES USED IN E-LEARNING

Communication technologies are generally categorized as asynchronous or synchronous. Asynchronous activities use technologies such as blogs, wikis, and discussion boards. The idea here is that participants may engage in the exchange of ideas or information without the dependency of other participants involvement at the same time. Electronic mail (Email) is also asynchronous in that mail can be sent or received without having both the participants' involvement at the same time.

Synchronous activities involve the exchange of ideas and information with one or more participants during the same period of time. A face to face discussion is an example of synchronous communications. Synchronous activities occur with all participants joining in at once, as with an online chat session or a virtual classroom or meeting.

Virtual classrooms and meetings can often use a mix of communication technologies.

In many models, the writing community and the communication channels relate with the E-learning and the M-learning communities. Both the communities provide a general overview of the basic learning models and the activities required for the participants to join the learning sessions across the virtual classroom or even across standard classrooms enabled by technology. Many activities, essential for the learners in these environments, require frequent chat sessions in the form of virtual classrooms and/or blog meetings. Lately context-aware ubiquitous technology has been providing an innovative way for written and oral communications by using a mobile device with sensors and RFID readers and tags (Liu & Hwang, 2009).

E-LEARNING 2.0

The term e-Learning 2.0 is used to refer to new ways of thinking about e-learning inspired by the emergence of Web 2.0. From an e-Learning 2.0 perspective, conventional e-learning systems were based on instructional packets that were delivered to students using Internet technologies. The role of the student consisted in learning from the readings and preparing assignments. Assignments were evaluated by the teacher. In contrast, the new e-learning places increased emphasis on social learning and use of social software such as blogs, wikis, podcasts and virtual worlds such as Second Life. This phenomenon has also been referred to as Long Tail Learning See also, "Minds on Fire:Open Education, the Long Tail, and Learning 2.0" by John Seely Brown and Richard P. Adler, 2008.

The first 10 years of e-learning (e-learning 1.0) was focused on using the internet to replicate the instructor-led experience. Content was designed to lead a learner through the content, providing a wide and ever-increasing set of interactions, experiences, assessments, and simulations. E-learning 2.0, by contrast (patterned after Web 2.0) is built around collaboration. E-learning 2.0 assumes that knowledge (as meaning and understanding) is socially constructed. Learning takes place through conversations about content and grounded interaction about problems and actions. Advocates of social learning claim that one of the best ways to learn something is to teach it to others.

There is also an increased use of virtual classrooms (online presentations delivered live) as an online learning platform and classroom for a diverse set of education providers such as Fox School of Business for Temple University, Minnesota State Colleges and Universities, and Sachem School District.

In addition to virtual classroom environments, social networks have become an important part of E-learning 2.0. Social networks have been used to foster online learning communities around subjects as diverse as test preparation and language education. Mobile Assisted Language Learning (MALL) is a term used to describe using handheld computers or cell phones to assist in language learning.

3D VIRTUAL LEARNING ENVIRONMENTS

As another example, Second Life has recently become one of the virtual classroom environments used in colleges and universities, including University of Edinburgh (UK), Harvard University (USA), and the Open University (UK),. Language learning in virtual worlds is the most widespread type of education in 3D virtual spaces, with many universities, mainstream language institutes and private language schools using 3D virtual environments to support language learning.

SERVICES

E-learning services have evolved since computers were first used in education. There is a trend to move towards blended learning services, where computer-based activities are integrated with practical or classroom-based situations.

COMPUTER-BASED LEARNING

Computer Based Learning, sometimes abbreviated to CBL, refers to the use of computers as a key component of the educational environment. While this can refer to the use of computers in a classroom, the term more broadly refers to a structured environment in which computers are used for teaching purposes. The concept is generally seen as being distinct from the use of computers in ways where learning is at least a peripheral element of the experience (*e.g.*, computer games and web browsing).

COMPUTER-BASED TRAINING

This section needs additional citations for verification.

Please help improve this article by adding reliable references. Unsourced material may be challenged and removed. (September 2007)

Computer-based training (CBT) services are where a student learns by executing special training programmes on a computer relating to their occupation. CBT is especially effective for training people to use computer applications because the CBT programme can be integrated with the applications so that students can practice using the application as they learn. Historically, CBTs growth has been hampered by the enormous resources required: human resources to create a CBT programme, and hardware resources needed to run it. However, the increase in PC computing power, and especially the growing prevalence of computers equipped with CD-ROMs, is making CBT a more viable option for corporations and individuals alike. Many PC applications now come with some modest form of CBT, often called a tutorial. Web-based training (WBT) is a type of training that is similar to CBT; however, it is delivered over the Internet using a web browser. Web-based training frequently includes interactive methods, such as bulletin boards, chat rooms, instant messaging, videoconferencing, and discussion threads. Web based training is usually a self-paced learning medium though some systems allow for online testing and evaluation at specific times. Recent years have seen an explosion in online training for educators by content providers such as Knowledge Delivery Systems, Atomic Learning, PBS Teacherline, and more.

COMPUTER-SUPPORTED COLLABORATIVE LEARNING (CSCL)

"Computer-supported collaborative learning (CSCL) is one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology. Collaborative or group learning refers to instructional methods whereby students are encouraged or required to work together on learning tasks. It is widely agreed to distinguish collaborative learning from the traditional 'direct transfer' model in which the instructor is assumed to be the distributor of knowledge and skills. " Lehtinen et al.

Computer-supported collaborative learning (CSCL) is a method of supporting collaborative learning using computers and the internet. It is related to Computer Supported Cooperative Work (CSCW) and cuts across research in psychology, computer science, and education.

The technology allows individuals who are far apart to collaborate on-line. The use of these tools is increasing, however many teachers are still new to what tools are available on the internet and how to use them effectively. This article details some of the tools available and suggests ways to use them to promote online learning and the collaboration of students.

ABOUT CSCL

CSCL is a method for bringing the benefits of collaborative learning and cooperative learning to users of distance or co-locative learning via networked computers, such as the courses offered via the Internet or in a digital classroom. The purpose of CSCL is to scaffold or support students in learning together effectively. CSCL supports the communication of ideas and information among learners, collaborative accessing of information and documents, and instructor and peer feedback on learning activities. CSCL also supports and facilitates group processes and group dynamics in ways that are not achievable by face-to-face communication (such as having learners label aspects of their communication).

CURRENT RESEARCH

Due to the surge of distance learning via the Internet, including courses that employ CSCL, it is important that educators and instructional designers better understand the benefits and limitations of CSCL. Like many educational activities, it is difficult to evaluate the effectiveness and efficiency of CSCL activities. Early efforts focused on suspected detrimental effects of communication filtering of computer mediated communication (CMC) and ignored the potential benefits of CMC. Historically, the lack of evidence that technological innovations have improved learning in formal education highlights the need for evidence of whether, how and when expected improvements in learning take place.

A key characteristic of CSCL research is its diversity in methodology: CSCL researchers apply laboratory experimental methods, quasi-experimental approaches, discourse analyses, or case studies. Qualitative data shows high regard for use of CSCL tools as aides to learning in the classroom.

MEANS AND MEDIUMS

Online Collaboration tools are the means and mediums of working together on the Internet that facilitate collaboration by individuals who may be far apart. The use of collaborative tools is increasing, however many teachers are still new to what tools are available on the internet and how to use them effectively.

BENEFITS

If Collaborative learning is the idea of bringing together learners to work and learn in a collaborative manner, then Computer Supported Collaborative Learning (CSCL),or Web 2.0, tools accomplishes this task either synchronously or asynchronously. {See Asynchronous Learning} Online collaborative tools provide a central locale for these types of interactions.

- Saves time. Students can work either together or independently, either way contributing to the success of their group overall.
- Develops oral and written communication and social interaction skills.
- Allows for interactions with students outside their class, school, city, state and even country. Prepares young students for upper grades and the technology tools they will be encountering there.
- Allows for students who are unable to attend school to keep up with their peers.
- Share ideas.
- Increases student motivation.
- Encourages different perspectives views.
- Aids in metacognitive and evaluative thinking skill development.
- Develops higher level, critical-thinking skills thanks to use of problem-solving approaches.
- Encourages student responsibility for learning.
- Establishes a sense of learning community.
- Creates a more positive attitude about learning.
- Promotes innovation in teaching and classroom techniques.
- Enhances self management skills.
- Develops skill building and practice. Common skills which often require a great deal of practice can be developed through these tools, and made less tedious through these collaborative learning activities in and out of class.
- Develops social skills.

AVAILABLE TOOLS

A variety of tools are available via the Internet to assist in online collaboration efforts.

Wikis: Wikis are a type of website in which users, such as students, can easily add, remove, or edit the content.

APPLICATION IN EDUCATION

Teachers can engage students by using wikis to create a space for collaborative essays. Students can posts their reflections and share information. Students working collaboratively on research projects can use wiki spaces as a depot for note taking, or to learn from other student research projects.

Teachers can also create a compendium of concepts for the course to use as a study guide. Wikis can serve as teacher or classroom webpages, with the added benefit that students themselves can edit the content. For example, students can change the page that displays the weeks' spelling words.

Blogs: Blogs are interactive, online journals.

Teachers may write a blog for students in their classrooms with links to Internet sites which aide in learning and/or research tasks. Teachers may have students use blogs as learning reflections, story writing, *etc.* Viewers can leave comments which aide the writer in his/her writing development.

Learning Management Systems: Learning management system (LMS) or course management systems (CMS) are an online package to help educators create effective online learning communities.

Teachers can post discussion topics, questions, homework or resources in the forums, and answer questions or send messages online. Or they can set quizzes for test review. It can provide a secure place for email exchange. A CMS helps to establish a learning community online. For home-bound children, a CMS can provide the learning experience and collaborative opportunities missed in the classroom.

Survey Systems: These tools allow the creation and administration of surveys completely online.

These tools are great for both teachers and students. Surveys can easily be turned into quizzes with multiple choice answering, and open-ended questioning. The survey can render your results for you, and even synthesize and analyze the results into a variety of formats including charts and graphs.

Online Image/Video Sharing: These tools allow for the sharing of image and video files specifically and often allows commentary, dialogue and/or exchanges.

Teachers and students can use these tools to discuss and analyze photos, videos, *etc.* They can upload pictures or video from their computer, camera, or from cell phone. It's a great place to store and organize photos and videos, however it is not entirely secure.

The students can then actively engage with the image and think about and discuss specific aspects. Specifically in applications such as Flickr, students can organize pictures by tags. As a collaboration project, teachers can encourage students to upload pictures about a topic, for example a world heritage site, and invites users to contribute tags to the images.

In applications, such as VoiceThread, students can add voice and written commentary to the overall video, picture or document. The comments are sequenced, so that late-comers can follow the dialogue.

Video-conferencing/chat/file Sharing Applications: These are various applications which allow students from around the world to engage in synchronous conferencing through live video feeds, video replays, chatting, and/or voice.

Teachers can create online working spaces for student groups within their classrooms, across classrooms, grade levels, school, states, the nation, and even the world. Students can work collaboratively on group assignments, and keep active communications ongoing with e-pals.

Online Collaborative Work Spaces: Various web-based applications which allow groups of students to work together on common documents in various formats either synchronously or asynchronously. Many applications include to-do lists, calendars, and ample storage space. These spaces are not always secure, however. Some applications include blogs and wikis for group work, as well.

You can upload various types of documents or spreadsheets, even PowerPoint presentations in many applications and have students work entirely online asynchronously on a product. Partners and groups can be inside the same classroom, or across the country or world from one another.

Online Whiteboards: Various web-based applications which allow students to chat, while writing, drawing, demonstrating, *etc.* in/on an electronic whiteboard. Often these applications let you save what has been written on the whiteboard as a picture file, and/or print them.

In these types of Web 2.0 tools, students can brainstorm, create graphics together, and engage in peer-to-peer tutoring in skills and concepts such as multiplication or division. These can often be video-taped to show process, and/or saved as an image file and printed for review.

Virtual Worlds: Virtual worlds are areas online where students can interact with each other with avatars.

Virtual Worlds, such as Whyville, have much potential in Education by providing fun, highly motivating, places for collaboration. In these virtual worlds new snippets are constantly being added that provide additional functionality to the system. This environment provides ample opportunity for social skills development and writing/reading skill development through a fun, non-intimidating manner.

Mind Maps: Mind maps are diagrams used to represent words, ideas, tasks, or other items.

Teachers can utilize brainstorming approaches that can generate ideas without regard for a more formal, hierarchical organization system. Notetaking, organizing, connecting, summarizing, revising, and general clarifying of thoughts can be accomplished with this tool.

Teacher's Role: Instructors play a vital role in facilitating online collaborative learning. Researchers indicate that strong instructor support, frequent instructor-student interaction, and superior organizational skills are critical elements of successful online collaborative learning (Ku, Lohr, & Cheng, 2004). According to the Shank study, competencies of online instructors and those planning the use of online collaboration tools in the traditional classroom setting, are as follows:

Administrative: The primary goal is to assure smooth operations and reduce instructor and learner overload.

Design: The primary goal is to assure successful learning outcomes.

Facilitation: The primary goal is to provide social benefits and enhanced learning.

Evaluation: The primary goal is to assure that learners know how they will be evaluated and help learners meet objectives.

Technical: The primary goal is to assure that barriers due to technical components are overcome.

TECHNOLOGY-ENHANCED LEARNING (TEL)

The existing definitions for technology enhanced learning spread very broad and change continuously due to the dynamic nature of this evolving research field(see example links below.) Hence, the definition of TEL must be as broad and general as possible in order to capture all aspects:

Technology enhanced learning (TEL) has the goal to provide socio-technical innovations (also improving efficiency and cost effectiveness) for learning practices, regarding individuals and organizations, independent of time, place and pace. The field of TEL therefore describes the support of any learning activity through technology.

A learning activity can be described in terms of the:

> *Learning Resources: creation, distribution, access, compilation, consumption of digital content; tools and services*
>
> *Actions: communication, collaboration, interaction with software tools*
>
> *Context: time and location*
>
> *Roles: A learning activity is carried out by various actors in changing roles (e.g., student, teacher, facilitator, learning coach, human resource or education manager).*
>
> *Learning Objective: to support every human in achieving her or his learning goals, respecting individual as well as organizational learning preferences. Learning activities can follow different pedagogical approaches and didactic concepts. The main focus in TEL is on the interplay between these activities and respective technologies. This can range from enabling access to and authoring of a learning resource to elaborate software systems managing (e.g., learning management system, learning content management systems, learning repositories, adaptive learning hypermedia systems, etc.) and managing (human resource management systems; tools for self-directed learning, etc.) the learning process of learners with technical means.*

TEL is often used synonymously for eLearning even though there are significant differences.

The main difference between the two expressions is that TEL focuses on the technological support of any pedagogical approach that utilizes technology. However this is rarely presented as including print technology or the developments around libraries, books and journals in the centuries before computers.

EDUCATIONAL TECHNOLOGY DESIGN

Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources." The term educational technology is often associated with, and encompasses, instructional theory and learning theory. While instructional technology covers the processes and systems of learning and instruction, educational technology includes other systems used in the process of developing human capability. Educational Technology includes, but is not limited to, software, hardware, as well as Internet applications and activities.

PERSPECTIVES AND MEANING

Educational technology is most simply and comfortably defined as an array of tools that might prove helpful in advancing student learning. Educational Technology relies on a broad definition of the word "technology". Technology can refer to material objects of use to humanity, such as machines or hardware, but it can also encompass broader themes, including systems, methods of organization, and techniques. Some modern tools include but are not limited to overhead projectors, laptop computers, and calculators. Newer tools such as "smartphones" and games (both online and offline) are beginning to draw serious attention for their learning potential.

Those who employ educational technologies to explore ideas and communicate meaning are learners or teachers.

Consider the *Handbook of Human Performance Technology*. The word technology for the sister fields of Educational and Human Performance Technology means "applied science." In other words, any valid and reliable process or procedure that is derived from basic research using the "scientific method" is considered a "technology."

Educational or Human Performance Technology may be based purely on algorithmic or heuristic processes, but neither necessarily implies physical technology. The word technology, comes from the Greek "Techne" which means craft or art. Another word "technique", with the same origin, also may be used when considering the field Educational technology. So Educational technology may be extended to include the techniques of the educator.

A classic example of an Educational Psychology text is Bloom's 1956 book, *Taxonomy of Educational Objectives*. Bloom's taxonomy is helpful when designing learning activities to keep in mind what is expected of—and what are the learning goals for— learners. However, Bloom's work does not explicitly deal with educational technology *per se* and is more concerned with pedagogical strategies.

According to some, an Educational Technologist is someone who transforms basic educational and psychological research into an evidence-based applied science (or a technology) of learning or instruction. Educational Technologists typically have a graduate degree (Master's, Doctorate, Ph.D., or D.Phil.) in a field related to educational psychology, educational media, experimental psychology, cognitive psychology or, more purely, in the fields of Educational, Instructional or Human Performance Technology or Instructional (Systems) Design.

But few of those listed below as theorists would ever use the term "educational technologist" as a term to describe themselves, preferring terms like "educator". The transformation of educational technology from a cottage industry to a profession is discussed by Shurville, Browne, and Whitaker.

One comprehensive history of the field is Saettler's *The evolution of American educational technology*. Another worthy title is Larry Cuban's *Oversold and Underused Computers in the Classroom*

For several decades, vendors of equipment such as laptop computers and interactive white boards have been claiming that their technologies would transform classrooms and learning in many positive ways, but there has been little evidence provided to substantiate these claims.

To some extent, the history of educational technology has been marked by a succession of innovations that arrive with much fanfare but often fade into the background once fully tested, as Cuban argues in the above title.Theories and Practices

Three main theoretical schools or philosophical frameworks have been present in the educational technology literature. These are Behaviorism, Cognitivism and Constructivism. Each of these schools of thought are still present in today's literature but have evolved as the Psychology literature has evolved.

CONNECTIVISM

Connectivism is "a learning theory for the digital age," and has been developed by George Siemens and Stephen Downes based on their analysis of the limitations of behaviourism, cognitivism and constructivism to explain the effect technology has had on how we live, how we communicate, and how we learn. Donald G. Perrin, Executive Editor of the International Journal of Instructional Technology and Distance Learning says the theory "combines relevant elements of many learning theories, social structures, and technology to create a powerful theoretical construct for learning in the digital age."

INSTRUCTIONAL TECHNIQUE AND TECHNOLOGIES

Problem Based Learning and Inquiry-based learning are active learning educational technologies used to facilitate learning. Technology which includes physical and process applied science can be incorporated into project, problem, inquiry-based learning as they all have a similar educational philosophy. All three are student centered, ideally involving real-world scenarios in which students are actively engaged in critical thinking activities. The process that students are encouraged to employ (as long as it is based on empirical research) is considered to be a technology. Classic examples of technologies used by teachers and Educational Technologists include Bloom's Taxonomy and Instructional Design.

THEORISTS

This is an area where new thinkers are coming to the forefront everyday. Many of the ideas spread from theorists, researchers, and experts through their blogs. Extensive lists of educational bloggers by area of interest are available at Steve Hargadon's "SupportBloggers" site or at the "movingforward" wiki started by Scott McLeod. Many of these blogs are recognized by their peers each year through the edublogger awards. Web 2.0 technologies have led to a huge increase in the amount of information available on this topic and the number of educators formally and informally discussing it. Most listed below have been around for more than a decade, however, and few new thinkers mentioned above are listed here.

- Hall Davidson
- Lawrence Tomei
- Karl Fisch
- Ian Jukes
- Jamie McKenzie, Ed.D.
- Scott McLeod
- Alan November
- Seymour Papert
- Will Richardson
- Gary Stager
- John Sweller
- Joyce Kazman Valenza
- David Warlick
- David Marcovitz
- George Siemens

BENEFITS

Educational technology is intended to improve education over what it would be without technology. Some of the claimed benefits are listed below:

- *Easy-to-access Course Materials:* Instructors can post the course material or important information on a course website, which means students can study at a time and location they prefer and can obtain the study material very quickly.
- *Student Motivation:* Computer-based instruction can give instant feedback to students and explain correct answers. Moreover, computer is patient and non-judgmental, which can give the student motivation to continue learning. According to James Kulik, who studies effectiveness of computers used for instruction, students usually learn more in less time when receiving computer-based instruction and they like classes more and develop more positive attitudes towards computers in computer-based classes
- *Wide Participation:* Learning material can be used for long distance learning and are accessible.
- *Improved Student Writing:* It is convenient for students to edit their written work on word processors, which in turn improves the quality of their writing. According to some studies, the students are better at critiquing and editing written work that is exchanged over a computer network with students they know.

- *Subjects Made Easier to Learn:* Many different types of educational software are designed and developed to help children or teenagers to learn specific subjects. Examples include pre-school software, computer simulators, and graphics software
- A structure that is more amenable to measurement and improvement of outcomes.

CRITICISM

Similarly to learning a new task or trade, there is special training that is involved with adding elements of educational technology to the classroom. Without proper training, teachers and students cannot benefit from devices that will improve the quality of education. Devices are a waste of time and money if teachers are not receiving proper training. Another disadvantage is that if teachers plan on using educational technology, they must come to the classroom prior to start time and set everything up and make sure it is all working.

EDUCATIONAL TECHNOLOGY AND THE HUMANITIES

Research from the Alberta Initiative for School Improvement (AISI) indicates that inquiry and project-based approaches, combined with a focus on curriculum, effectively supports the infusion of educational technologies into the learning and teaching process.

TECHNOLOGY IN THE CLASSROOM

- *Computer in the Classroom:* Having a computer in the classroom is an asset to any teacher. With a computer in the classroom, teachers are able to demonstrate a new lesson, present new material, illustrate how to use new programmes, and show new websites.
- *Class Website:* What better way to display your student's work, than to create a web page designed just for your class. Once a web page is designed, teachers can post homework assignments, student work, famous quotes, trivia games, and so much more. In current day society, children know how to use the computer and navigate their way through a website, so why not give them one where they can be a published author.
- *Wireless Classroom Microphones:* Noisy classrooms are a daily occurrence, and with the help of microphones, students are able to hear their teachers clearer. Children learn better when they hear the teacher clearly. The benefit for teachers is that they no longer lose their voices at the end of the day.

SOCIETIES

Learned societies concerned with educational technology include:

- Association for the Advancement of Computing in Education (AACE)
- Association for Educational Communications and Technology

- Association for Learning Technology
- International Society for Technology in Education (ISTE)
- Northwest Council for Computer Education
- Computer-Using Educators

HUMANISTIC DESIGN

To return to the myth of Theseus: Is curriculum a sword, or a thread? Are curricula designed, or are they spun? The image of curriculum as a sharp instrument, stabbing at ignorance, shaping the learner, is one that many humanists find repugnant. Spinning and weaving are more humane images. Thy process begins with shearing or combing a sheep, itself a non-invasive, non-injurious kind of animal husbandry. In Ariadne's time, before the invention of the spinning wheel, the wool was drawn from a distaff in one hand and wound on a spindle held in the other. Patience and persistence produced a strong and even thread.

The process of weaving is a natural process, invented by spiders millions of years before it was observed by humans. Such words as weave, warp, woof and weft all derive from the Greek word *hyphos,* a web. The language of spinning and weaving is the language of the arts. We weave stories, spin yarns. Relationships are not carved, but woven. We speak of knowledge as a seamless web. Linear models of curriculum development are blind to the dynamic way in which a designer moves backwards and forwards from one component to another, designing, adjusting, calibrating and synchronizing. A curriculum is not a photograph, but a narrative woven by the designer, the protagonists of which are learners and teachers. Curriculum technolog draws heaLlily on cognitive and experimental psychology. Humanistic curriculum relies on clinical psychology, and particularl on 'third force' therapies. These include transactional, transpersonal, *Gestalt,* clientcentred, integrative and Jungian approaches. In experimental psychology, a subject manipulates an object. In therapy, therapist and client together wea\re a healed consciousness.

Like curriculum technology, humanistic curriculum tends to ignore its historical roots. While conscious of its debt to Maslow and other modern psychologists, it is often unaware that most of its philosophy is pure Rousseau, and that many of its articles of faith were articulated generations ago by Froebel, Pestalozzi and Montessori. The rationale of contemporary humanistic psychology has been articulated most effectively by such writers as Maslow, and from his work can be drawn four basic principles with which most humanistic educators would appear to agree.

1. *People's primary needs are for growth and self-actualization:* These are b'being' needs, rather than deficit needs. Learners are viewed not as deficit systems, but as persons who are essentially healthy and who have an almost unlimited potential for growth. Unlike most neo-marxists, who see little benefit in trying to change people so long as unjust social structures remain intact, humanistic educators believe that the most effective way to change society is b!. facilitating the growth of individuals.

2. Psychological and social health depend on recognition and integration of the many different aspects of being, including the cognitive, the affective, the social, the somatic and the aesthetic. These include not only areas of objective knowledge, but also areas which are irreducibly subjective, such as the spiritual.
3. *The primary vehicle for growth is human relations:* There is at least a tacit recognition that the construction of meaning is essentially social. The relationship of the teacher and the learner is viewed as one of subject to subject. There is deep engagement and empathy, just as, in humanistic therapy, it is significant that the therapist tells the client not only 'You are worthwhile', but, rather, 'You are worthwhile to me'.
4. *The preferred learning mode is direct personal experience:* This is in contrast to the reliance ofthe curriculum technologists on the transmission of symbolic, usually verbal, information. Each of these principles deserves fuller explanation, but their essence can be captured in the generalization that humanistic education seeks to transcend the cognitive. Much of the discomfort of humanists regarding curriculum technology appears to spring from technology's almost exclusive attention to propositional knowledge and logical skills. In these areas, it has become highly effective, but at the cost of paying attention only to learning which can be communicated in words or numbers. To put it another way, curriculum technology focuses only on what might be termed public meaning. A humanistic curriculum focuses also on personal and interpersonal meaning.

Public meaning refers to knowledge and skill which can be accurately and impersonally communicated in words or symbols, like the proposition 3 + 3 =6. Science, history, economics and the other conventional disciplines lie mainly in the area of public meaning. So do such skills as swimming, typing, reading and calculating. The present-day school curriculum consists almost entirely of public meanings.

Personal meanings, on the other hand, are individual and idiosyncratic. Our self-concept is a private meaning. Our reaction to works of art is to a great extent personal and cannot be reduced to verbal formulas. As Kenneth Clark once said, 'It is extremely rare for anyone who is capable of the intense and dreamlike joy which we call aesthetic emotion to do more than utter cries of satisfaction.'

Our physical identity is personal, and so is our gender identity. These meanings are subjective. Most subjective of all areas is the spiritual, the means by which we 'transcend the limitations and conflicts of lived experience'.

In a recent paper, Foshay describes how he searched the literature in education and psychology for discussion of the human quest for deep meaning, and found it only when he came to the literature on theology. Polanyi calls such meanings 'tacit knowledge'. They cannot be wholly captured by words: 'The Tao that can be expressed is not the eternal Tao' Interperson; meanings are also subjective, but they are shared by two or more participants. A friendship has meaning for two people-a family, a sports team, a task force, a theatre company, a gang, a military unit, a party: all of these are replete with a complex of interpersonal meanings. These meanings can be described to outsiders, but they cannot be fully understood except by' participants. Public meanings can be learned via a television, a textbook, or a computer. Interpersonal meanings can be acquired only through the experience of the 'I-Thou'.

VOCATIONAL DESIGN

Improvement of Work Education at all stages of school education has been a major concern of the NCERT. Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal is the national apex research and development organisation in the field of Vocational Education. It is also one of the centres of international project on Technical and Vocational Education (UNEVOC) which is administered by the UNESCO.

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The important functions of the PSSCIVE include: to advise and assist the MHRD, Government of India, State Governments and Union Territory administrations in the implementation of Vocational Education (VE) and Work Experience (WE) programmes to function as the technical wing of the Joint Council of Vocational Education and the MHRD on all matters relating to VE and WE programmes; to promote, supervise and guide the establishment of comprehensive management system for vocational edu-cation at different levels, *i.e.*, national, state, district and institutional; to function as overall resource institution in the areas of VE and WE, both formal and non-formal. Other functions include: studying and monitoring the educational requirements of the country as a whole in regard to preparing manpower for development; developing need-based vocational programmes for neo-literates and other special groups; undertaking guiding and coordinating curriculum and instructional material development, staff development and training; dissemination of literature and research findings, monitoring and evaluation and offering consultancy to state governments in the areas of VE and WE; ensuring the uniformity of pattern in the context of national system of vocational education and maintaining quality standards including those of teaching professions at all levels; promoting excellence at all levels of various types of VE programmes, both formal and non-formal, throughout the country; catering to the needs of research and other studies in the field of VE and WE and in the related and supportive areas;

establishing equivalence of certificates and to accredit vocational institutions and programmes while keeping the quality parameters in view; promoting a national, regional and international network of vocational education information system and services based on voluntary cooperation of related and other organisations and facilitating effective access to information and to looking after the international aspects of voca-tional education and human resource development.

DEVELOPMENT PROGRAMMES

Vocational Curriculum: Curricula in Library and Information Science, Marketing and Salesmanship, Plant Protection, Clothing for the Family, Sericulture, Travel and Tourism Techniques and Plastic Technology have been revised. New curricula for the Vocational Counselling and Guidance, Processing of Agro-Forest Produce, and Watershed Management have been developed.

INSTRUCTIONAL MATERIALS FOR VOCATIONAL AND PRE-VOCATIONAL COURSES, NEO-LITERATES AND ADULTS

Instructional materials in the areas of Entrepreneurs hip Development, Crop Production, Bakery and Confectionery, Food Preservation, Mechanical Engineering Technology, Inland Fisheries, Sericulture and Vocational Guidance and Counselling have been developed. Materials for the adults as a part of continuing education in VE are being developed. Instructional Materials (Modules) for Pre-Vocational Courses in Nursery Raising, Aquaculture, Weed Technology, Bio-fertilizers, Handicraft, Designing and Making of Children's Garments, Retailing and Shorthand have been prepared. Instructional materials in Mechanical Engineering Technology for Class XI and Hortculture for Class XII have also been developed. The following 31 manuscripts developed during 1996-97 have been/are being sent to the states for multiplication and distribution to concerned schools.

Dairying	1
Dairy Technology	5
Office Management	1
Banking	1
Commercial Garment Designing and Making	4
Textile Designing	2
Building Maintenance	4
Rural Engineering Technology	6
Horticulture	5
Poultry Farming	1
Bakery and Confectionery	1

PREPARATION/REVISION OF GUIDELINE DOCUMENTS

The following guideline documents were prepared/revised:

- Vocational Handbook for Vocational Survey Workers (revised)
- Accreditation of NGOs and Private Institutions
- Guidelines for Organisation of In-service Training Programmes for the Vocational Teachers (revised)

VIDEO FILMS

Four video films on popularisation of vocational courses in the areas of Agriculture (Horticulture), Home Science and General Foundation Course were produced. Some of these films have already been telecast on the Doordarshan.

TRAINING PROGRAMMES

In order to improve instruction in the vocational schools, nine teacher training programmes in the areas of Entrepreneurship Development, Building Maintenance, Inland Fisheries, Bakery and Confectionery, Computer Science, Office Management, Guidance and Counselling and Accountancy were organised.

One training programme for the resource per sons/trainers for Generic Vocational Course (GVC) was also organised. A short-term training programme for key functionaries of states was organised to bring about conceptual clar-ity with regard to implementation of the programmes, of Vocational Education and Pre-Vocational Education.

EXTENSION

Three national meetings on Vocational Education for the employers in Agricultural Production, Food Processing, and Industries and Information Technology were organised. These meetings were attended by eminent academicians, industrialists, scientists and employers of the concerned areas. The reports of these national meetings were brought out. A national seminar on 'Apprenticeship Training for Self-Employment Support and Placement' was also held. In this seminar, experts from the MHRD, BOAT, DGET, State Directorates of Vocational Education and Industries participated. Draft guidelines for providing apprenticeship training were prepared.

Eight orientation programmes on Vocational Education for 327 key functionaries of the states/UTs of Bihar, Rajasthan, Karnataka, Tamil Nadu, Mahrashtra, Haryana, Orissa and Pondicherry were organised. One orientation programme on Pre-Vocational Education for the north-eastern states was organised at Imphal. Another orientation programme for key functionaries for 66 northern states on Pre-Vocational Education was organised at Lucknow.

The first issue of the bi-annual Indian Journal of Vocational Education was brought out. This journal highlights the growth of Vocational Education programme in the country and research and developmental work in this area.

Three issues of the quarterly bulle-tin Vocational Education were published and sent to concerned state officials and 4,000 schools. Eminent educationists of the country were invited to deliver extension lectures and share their experiences on pertinent issues in Vocational Education. These programmes are meant for professional enrichment of the faculty.

EVALUATION

The work of evaluation of voluntary organisation running vocational courses, receiving grants from MHRD, has been assigned to the PSSCIVE. Joint Evaluation Teams (JETs) were constituted for this purpose by the MHRD. These JETs visited NGOs in Delhi. Bihar, Maharashtra, Rajasthan, Orissa, Punjab., Uttar Pradesh, Manipur, Sikkim, Haryana, West Bengal and Kerala. The NGOs of Mahdya Pradesh are being evaluated. Reports of the evaluation of NGOs were submitted to the MHRD.

INTERNATIONAL RELATIONS

The UNEVOC centres have been created in more than 100 countries of the world with a view to networking national institutions and centres directly for bilateral cooperation and exchange of information dealing with three programme areas such as system development, infrastructures and information and communication networking. The PSSCIVE, as a UNEVOC Centre for India, has been very active as regards its roles and contributions in the international arena, particularly the UNEVOC activities coming under UNESCO. The UNEVOC inventory prepared by the UNEVOC Centre, Berlin, inter alia, includes a list of various activities and publications related to PSSCIVE. The institute has implemented the Cultural Exchange Programmes (CEP) with Belgium and Republic of Korea (South Korea) by initiating the process of exchange of information and documentation on Vocational Education as per the signed document of CEP between the two countries.

REGIONAL LEVEL INPUTS TO VOCATIONAL EDUCATION

The RIE, Bhubaneswar conducted a four-day orientation programme for key functionaries of the states on issues, trends and implementation strategies of vocationalisation of education.

SOCIAL RECONSTRUCTION CURRICULUM AND TECHNOLOGY EDUCATION

... to shape the experiences of the young so that instead of reproducing current habits, better habits shall be formed, and thus the future adult society be an improvement on their own. (Dewey, 1916)

In the first half of the century, during the depths of the Great Depression, Progressive educators set out to reform education by calling for a social reconstruction curriculum orientation. In this paper I will explore social reconstruction with regard to schools, curriculum, and technology education. In the first half of the paper I will explore what was meant by social reconstruction, the way in which it was implemented in experimental schools, and the legacy of social reconstruction. In the second half of the paper I will discuss the role of processes in technology education curriculum, provide ideas for organizing a social reconstruction curriculum orientation in technology education, and list examples of what a social reconstruction curriculum orientation in technology education is not.

SOCIAL DESIGN

In response to social conditions of the day, Progressive educators during the early half of the century were advocating a restructuring of education in this country. Many of the Progressives believed that, due to school practices, schools and society were caught in a dualistic relationship which separated the school from mainstream society and created an isolation of the schools. They believed that what happened under the auspices of the schools was not real or reflective of the problems in society (Bode, 1933; Counts, 1932; Cremin, 1977; Dewey, 1916; Dewey and Childs, 1933). Furthermore, the Progressives argued that the artificial environment of the schools was miseducative in that the youth of the country were not prepared to see and understand the values and issues which would confront them as they became adults (Dewey and Childs, 1933). As a result of these beliefs, some Progressives proposed that the schools create a new social order (Counts, 1932).

DEFINITION

Creating a new environment in the schools, "reconstructing" the existing environment, was the Progressive agenda, but how that was to be accomplished was not universally agreed upon (Cremin, 1976). As with any other idea, a range of opinions were held with Counts proffering, perhaps, the most radical opinion. Counts (1932) envisioned a restructuring of American society and economy as he said, "The times are literally crying for a new vision of American destiny. The teaching profession, or at least its progressive elements, should eagerly grasp the opportunity which the fates have placed in their hands." Others were less radical in their suggestions for reform, but did believe that social reconstruction was the central aim of a good education and was necessary in schools, if not, society at large. Citing that many members of society were far too concerned with individual needs, that the fervent nationalism of the times inhibited international cooperation, and that the economic depression was signaling problems with the existing society and economic structure (Dewey and Childs, 1933) mainstream Progressives believe that the schools could be structured in a new way, and, in turn, encourage students as future citizens to reconstruct society.

The focus of mainstream Progressives was on the restructuring of schools; an effort which many hoped would lead to eventual changes in society. For schools and students, mainstream Progressive educators had several goals which included: orienting students and helping them commit to the life in which they would participate; helping students to develop intellectual, aesthetic, or practical interests; setting up an environment which would lead to a deeper understanding of a democratic way of life; and reconstructing the procedures of the school through experimentalism (Hullfish, 1933). Mainstream Progressive educators differed with Counts in that they saw a future for the existing democracy. About the social reconstruction of the mainstream Progressives, Dewey and Childs (1933) said:

> *Our continued democracy of life will depend upon our own power of character and intelligence in using the resources at hand for a society which is not so much planned as planning —a society in which the constructive use of experimental method is completely naturalized. In such a national life, society itself would be a function of education, and the actual educative effect of all institutions would be in harmony with the professed aims of the special educational institution. (Dewey and Childs, 1933)*

Interestingly, the Progressives based their interpretation of social reconstruction in experimentalism, science, and technology. Experimentalism and faith in science and technology are fundamental to the philosophy of pragmatism. As a leading pragmatic philosopher, Dewey conceived of pragmatism as a uniquely American philosophy which dealt with the concepts of the instrumentalism of technology and the experimentalism of science as inquiry (Hickman, 1990; Smith, 1980). It is no wonder, then, that Dewey advocated experimentation in schools for both the students via the curriculum and for administrators as they determined the structure of schools.

Moreover, Dewey and Childs (1933) spoke of the use of instrumentalism as a technology of education which would influence society: "An identity, an equation, exists between the urgent social need of the present and that of education. Society, in order to solve its own problems and remedy its own ills, needs to employ science and technology for social instead of merely private ends." (p.64) Make no mistake about it, though, the purpose of the use of science and technology was to be a social purpose, not an individual purpose and not a business purpose. Individual and business values and actions were clearly criticized by the Progressives who linked these values and actions to the evident ills within society during the first half of the century (Bode, 1933; Counts, 1932; Dewey and Childs, 1933).

IMPLEMENTATION

A number of experimental or laboratory schools were set up during the Progressive Era in education. It is from these schools that examples of what social reconstruction would look like in education can be drawn. Bode (1933) explains social reconstruction as a "continuous reconstruction of experience" in daily school practice with the following examples: This reconstruction of experience, if it is to have any significance, must take the form of ctual living and doing. Consequently the school must be transformed into a place where pupils go, a not primarily to acquire knowledge, but to carry on a way of life. That is, the school is to be regarded as, first of all, an ideal community in which pupils get practice in cooperation, in self-government, and in the application of intelligence to difficulties or problems as they may arise. In such a community there is no antecedent compartmentalization of values.

There are a number of important points here about social reconstruction. Social reconstruction involves active participation through "doing." However, this is not mindless drill, skill development, or even the completion of personally chosen projects, because the Progressives clearly intended a social purpose to all activity. They viewed the school as a community in which values and habits useful in the greater community would be instilled through practice. This was not to be an activity such as job training or skill development which fit students into preconceived notions of what adults believed they should become.

That is why there was an emphasis on self-government by students and that is why Bode (1933) continued: "Shopwork, for example, is not dominated by the idea of personal profit, but becomes a medium for the expression of aesthetic values and social aims. The quest for knowledge is not ruled by the standards of research, but is brought into immediate relation with human ends. Judgements of conduct are not based upon abstract rules, but on considerations of group welfare." The message is clearly one of social purpose as the guiding force for the reconstruction of experience within the school. Social purpose also guided the selection of content and activities which formed the curriculum. The social purpose is documented in an overview of the science and technology curriculum at The Ohio State University Elementary School and Kindergarten in 1935: "In evaluating our results, we asked ourselves thoughtfully: 'Does the educational experience we are setting up provide for real participation by each student in each of these functions of living?'" (Publications Committee, 1935) The curriculum of the laboratory school included a core of study about the preparation of materials which was specified to take place in the science, all of the arts, and the home economics laboratories. Industry, distribution, and control were some of the topics to be studied in this core.

The Ohio State University laboratory school was organized about the concept of social reconstruction and was often cited as an exemplar of social reconstruction curriculum in action. The secondary school operated on the same guiding principles. The effectiveness of the secondary programme was documented, uniquely, by the first graduating class who took it upon themselves to write and publish a book about their perceptions of the social reconstruction programme they had followed (Class of 1938, 1938).

In their extensive work the students explained how they created their school environment with teachers who served as friends and advisors. In the early years, much of the work that was done under the auspices of industrial arts involved modifying their own school environment by refurbishing the school building In the experimental schools of the Progressive Era social reconstruction curriculum involved student self government, the evolution of a community consciousness on the part of students, and group project work which focused on the school, local, national, and international communities.

THE LEGACY

Very little evidence of the social reconstruction curriculum remains today. Vestiges of practices initiated in the experimental schools can be seen in efforts to operate student councils, attempts to provide students some free choice in projects, and endeavors to maintain school laboratories in technology and consumer science education. What happened? Dewey and Childs 1933 critique of the failure to adopt social reconstruction educational practices during that era has an all too familiar ring today:

> *Why, even when the social concepts were retained in theory, were they treated in a way which left them mainly only a nominal force, their transforming effect on practice being evaded? Why were they so often used merely to justify and to supply a terminology for traditional practices? The reason which lies on the surface is that an abstract and formal conception of society was substituted for the earlier formal concept of the individual. General ideas like the transmission and critical remaking of social values, reconstruction of experience, receive acceptance in words, but are often merely plastered on to existing practices, being used to provide a new vocabulary for old practices and a new means for justifying them.*

Essentially, Dewey and Childs are critiquing the failure to move from the academic rationalist curriculum of the Greek tradition and the personal needs curriculum of the Herbartian tradition. Educators are still struggling with these, and other curriculum orientations today. Technology education has not escaped this struggle Cremin (1976 & 1977), with the benefit of hindsight offers an additional explanation of the lack of implementation in schools of the Progressives' idea of social reconstruction. He believes that Dewey failed to resolve the dualism between the school and society that he Phenomenologists and critical scientists provide other reasons for the lack of enduring social reconstruction curriculum reform. Vandenberg (1971), in a phenomenological analysis, views the reform efforts of the twentieth century as a Hegelian dialectic in which social reconstruction was an alternative view promulgated as a result of child-centered beliefs and was recombined with life-adjustment ideas in the post World War II period. More recently, Gonzalez (1982), critiquing from a Marxist perspective, charges that the Progressives "never challenged the tenets of capitalist production".

Creating a Social Reconstruction Curriculum for Technology education Technology educators have relied upon technical processes as a means of generating curriculum content. This is true for traditional programmes as well as contemporary programmes. Teaching about technical processes is essential in a "hands on" programme. A social reconstruction curriculum orientation would be "hands on." It is the way in which the technical processes are organized that distinguishes the curriculum orientation. In this section I will discuss the prominent role of technical processes in technology education curriculum, examples of a social reconstruction orientation in technology education, and what is not a social reconstruction curriculum orientation in technology education.

PROCESSES AS TRADITIONAL CURRICULUM CONTENT

There are many ways in which to identify and define appropriate content for technology education. To this time, technology educators have concentrated primarily on categorizing processes either via the traditional content of industrial arts or through contemporary proposals for industrial technology education and technology education. For example, industrial arts educators started with a material such as wood or a process such as drawing and using a form of task analysis categorized the processes students needed to know in order to transform the material or create an acceptable drawing (Silvius & Bohn, 1976; Silvius & Curry, 1967; Wilber, 1948). The approach used in the Maryland Plan appears to eschew a focus on processes while students select content. However, processes eventually aretaught as they are required by the individual student's project (Maley, 1973). In the same manner, industrial technology educators started with an inputs-processes-outputs model of manufacturing or constructing and categorized a wider array of processes needed to manufacture and construct (Towers, Lux, & Ray, 1966). The industrial technology education curriculum was more inclusive in that it incorporated the processes involved in managing the businesses of manufacturing and construction. Contemporary technology education curriculum follows the same route as industrial technology curriculum by using an inputs-processes-outputs model for generating curriculum (Snyder & Hales, 1981). Some variation exists with the British models of design and technology curriculum in that problem solving becomes the focus of the curriculum and problem solving processes in addition to technical processes are used to organize curriculum (Barlex & Kimbell, 1986; Kimbell, 1982; Williamson & Sharpe, 1988). It is clear that technology educators teach about processes. The differences in the curriculum orientations(when and how the processes are taught) are rooted in teachers' beliefs about education and students. These beliefs cause the teacher to select and organize the processes in a variety of ways. The differences lie in the way in which the teacher chooses to slice the pie of the current content universe of technical processes.

ORGANIZING TECHNOLOGY EDUCATION WITH A SOCIAL RECONSTRUCTION

Orientation: Technical processes are taught only as the needto know them in order to solve the social problem arises. For example, pressing social problems such as designing and constructing low cost housing for the homeless, refurbishing low cost housing, or retrofitting housing with energy saving devices becomes the thrust of a social reconstruction curriculum in a construction class. Students may never get a chance to try all of the processes, such as installing shingles on a roof or wiring, needed in order to build a contemporary home.

The teacher is more concerned about the social problem and creating a community with students and society and is less concerned about "covering the content." Only the technical processes needed to construct the problems which have particular relevance to technology are alternative form of housing are taught to those students who need to know the technical processes. The teacher also trusts that the greater social goal is of more value than specific content. The teacher believes that the experience of solving a problem such as creating low cost shelter for the homeless will instill in students habits and enthusiasm for seeking out the knowledge and skills needed to take on additional problems which will involve other knowledge and skills. The teacher also believes that by example and practice with selected processes that attitudes of safety and pride in quality will transfer to new processes.

In this way the teacher hopes to help a student to be not dependent upon instruction in order to function as an adult in society, but to be willing to experiment and to try new ideas and skills. We are not lacking in pressing social problems which relate to technology. Each content area of technology education can be used as a vehicle for attacking social concerns. Some examples include:

TRANSPORTATION

1. Designing and creating less polluting power systems for vehicles
2. Designing and creating prototype alternative transportation systems for the community and presenting those designs to city council

MANUFACTURING

1. Investigating the effects of local manufacturing firms policies on the local environment and either honoring the firms or approaching the firms with suggestions for improvement.
2. Investigating and attempting to develop biodegradable polymers
3. Creating a manufacturing business which makes a product identified as valuable to a select market such as senior citizens or low socio-economic status (SES) citizens in the local community and marketing that product to them on a cost recovery basis.

COMMUNICATION

1. Creating and testing personal emergency communication devices for handicapped people
2. Examining advertising claims by doing product testing and reporting the results to the local community

CONSTRUCTION

1. Conducting an energy audit on the school building and making recommendations to the school board for retrofitting energy saving devices
2. Conducting energy audits and correcting the deficiencies on students' homes, homes of the elderly, and homes of low SES citizen

The list of examples is bounded only by the imagination of the students and teachers who, in partnership, implement a social reconstruction curriculum orientation in technology education.

CHALLENGES FOR EDUCATIONAL TECHNOLOGY

Challenges for educational technology encompass a range of obstacles and complexities that educators, policymakers, and stakeholders face in integrating and leveraging technology effectively in educational settings. One significant challenge is the digital divide, which refers to disparities in access to technology and digital resources among different socioeconomic and demographic groups. Bridging this gap requires efforts to ensure equitable access to technology and connectivity, particularly in underserved communities. Moreover, resistance to change and technological adoption poses a challenge to the effective implementation of educational technology initiatives. Educators may encounter reluctance or skepticism among colleagues or administrators, hindering the adoption of innovative pedagogical practices and digital tools. Overcoming resistance to change involves fostering a culture of innovation, providing professional development opportunities, and demonstrating the value of technology in enhancing teaching and learning outcomes. Furthermore, ensuring the quality and effectiveness of educational technology interventions is a persistent challenge. With the proliferation of digital resources and tools, educators must critically evaluate the relevance, reliability, and pedagogical value of technology-enhanced learning materials. Additionally, issues related to data privacy, security, and digital citizenship raise concerns about the ethical use of technology and the protection of student information and privacy rights. The book on Challenges for Educational Technology provides insights into the obstacles and opportunities shaping the integration and implementation of technology in education, offering strategies for overcoming hurdles and maximizing its potential.

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