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PRINCIPLES AND TECHNOLOGIES FOR IMPROVING STUDENT LEARNING *

Abstract: Technology helps people learn, be creative, and become players and communicators in a global village. Being on the Internet allows students of all ages to engage in knowledge building on a worldwide stage. New learning opportunities may never reach students in high poverty or isolated schools except through the use of technology. The focus of this paper will be on the principles and technologies that enhance the opportunities for student–centered learning. The first part of this paper will discuss research–validated principles that influence learning, key issues in using educational technology to support learner-centered principles and practices, and criteria for doing technology evaluation. It is important for educators to understand factors for maximizing student learning and motivation with instruction that (1) is meaningful and relevant from the individual learner's perspective, (2) provides appropriate learning challenges and standards, (3) accommodates needs to be supported in critical thinking and learning skills, (4) attends to the climate and context in which learning occurs, (5) honors individual needs for choice and control, (6) supports individual interests and creativity, (7) provides positive social interactions and interpersonal relationships, and (8) adapts to a variety of individual differences. The second part of the paper illustrates five ways in which technology can support learning (Based on the 1999 report, How People Learn, from the National Research Council, Bransford, Brown & Cocking). Technology can be used to help supply five key conditions for learning: (1) real-world contexts for learning; (2) connections to outside experts (3) visualization and analysis tools; (4) scaffolds for problem solving; and (5) opportunities for feedback, reflection and revision. The final part of the paper focuses on the need for both small- and large-scale studies that evaluate the goals, assumptions, and uses of technology in classrooms and the match or mismatch of these uses with principles of learning and transfer. In short, the focus of the technology evaluation should be on learning and the learners and not the technology. The long-term goal is to

build schools as learner-centered communities by expanding the notion of collaboration, which will transform current educational systems. Technology has an obvious role in both of these areas, but it is a role that must evolve from the foundation of research-validated principles and practices.

Today's world has grown smaller because of technology. Satellit trucks allow us to view images from anywhere in the world. Cellula telephones allow instantaneous communication. Palm top computer give us powerful tools to plan, store, and present data. Satellites, wit power imaging technology provide us with high quality images fron hundreds of miles in space.

New technology has created two broad changes in our world to day. First, there is a changing economy. New technology is makin workers more productive. In addition, financial trade, communications and assets are being acquired globally. An example is "Sony" who ha major holdings in the entertainment business in the U.S.

Second, there is a changing workplace. Globally, we have entere into what some have termed, "The information age." There are man sources of information that are available electronically that can be ac cessed at the click of a mouse. Therefore, knowledge is quickly becom ing a major commodity. I believe that one skill that educated perso must have is the skills necessary to search the vast number of informa tion sources that are available, which address the problems that need t be solved (Report from National Commission on Mathematics and Sci ence Teaching for 21st Century, 2000).

These global changes have two implications for educators. First we must train our children to use the technology and information tool that are available to them so that they can work effectively in our globa society. Second, we must use technology to create a more effectiv teaching learning system to deliver our lessons. If technology is to b used effectively in teaching, it must be used to create a student-centere learning environment. This paper will focus on the principles and tech nologies that enhance the opportunities for student-centered learning.

Instructional and Motivational Factors

The first part of the paper will provide a framework for the discussion. This includes a review of key research-validated instructional and motivational factors that maximize student learning and motivation, the ways in which technology can be used to maximize key conditions for learning, and criteria for doing technology evaluation.

There are eight key instructional and motivational factors that are needed to maximize student learning and motivation. These are shown in Figure 1.

First, instruction must me made meaningful and relevant from the individual learner's perspective. When instruction is learner-centered it implies, according to Margaret Riel (2001) that the learner "is actively engaged in the process of knowledge construction." This means that learning is anything but "boring." In a learner-centered environment, the learners take part in setting the goals, which are then guided by the teacher. I have seen this in my own research in a High School in Chicago. A Biology teacher told me that one-day she has set out some beakers for an experiment. However, she forgot to label the beakers and had no idea what was in them. Instead of throwing the contents out, she challenged her class to run some tests to find out what was in them. She said that the students were very interested and had a hard time leaving the class when it was done. The next day, she said that the students were so focused on this task, that when they came into the class, they went right to work instead of talking. This teacher turned a mistake into a student-centered learning opportunity that the students will remember for a long time.

Second, instruction must provide appropriate learning challenges and standards. Classrooms in our technology rich world can no longer reduce learning to memory exercises. While there are areas that require extensive memorization, students must be taught to think and apply that knowledge. In addition, standards of student performance must be established so that students will know what is expected of them. Riel (2001) calls this being "Assessment Centered." Teachers must know "what students are learning and what they need to know. This means that the curriculum needs to be matched to the classroom assessments.

The assessments should flow out of the curriculum. A major focus should be on criterion referenced, rather than norm-referenced. One problem with norm-referenced testing is the temptation to "teach to the test." When this is done, the test, rather than the curriculum drives the learning process. In addition to tests, teachers need to find other methods of assessment such as student portfolios to determine the quality of student work. I will talk more about this later.

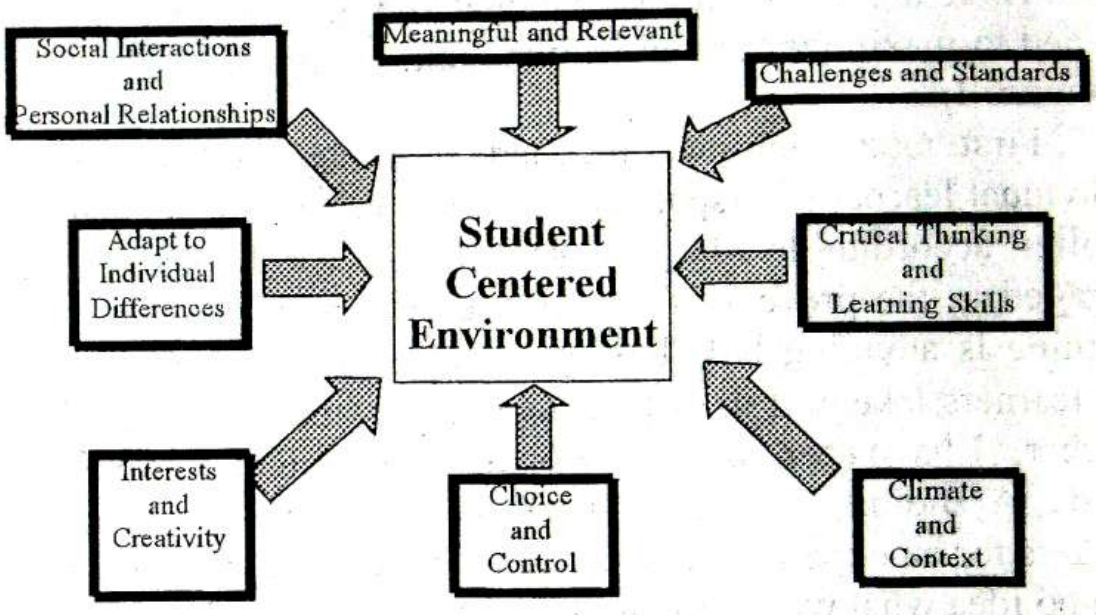

Figure 1: Factors in A Student/Centered Learning Environment

In addition, the teachers must be, what Riel (2001) terms "Knowledge Centered." Teachers must have the knowledge base to be able to evaluate the essential skills and knowledge that students need in a particular discipline. This means that

Third, instruction must accommodate needs and be supported in critical thinking and learning skills. This is also related to being "Assessment Centered" Critical thinking involves skills and dispositions. Dispositions are attitudes regarding higher-level knowledge. Tishman et. al. (1995) has identified four ways to help students develop higher order knowledge. These are to use real world examples; make comparisons across disciplines; encourage interaction by engaging students in problem solving activities or inquiry; finally, give positive feedback to students when they demonstrate the appropriate use of higher order knowledge that is relevant to the subject being studied.

Fourth, instruction should attend to the climate and context in which learning occurs. Recent brain research suggests, "The richness of early learning experiences affects the physical development of the brain and may be a major cause of intellectual development. If these new theories linking learning experiences with brain development come to be accepted, the optimal match between characteristics of the learner and the learning environment, rather than parental genetic code, might be seen as responsible for school success."(Riel 2001, p. 10) This means teachers must be concerned not only about children learning, but how they learn it. Teachers must crease an environment that targets a broad range of learning styles.

Fifth, instruction should honor individual needs for choice and control. This is another aspect of being "Learner Centered." McCombs (2000) notes that teachers must value the unique perspectives of the learner. For example, the student could be involved in classroom assessment of their work. Students could be asked to help design the rubric used in evaluation and then asked to apply it to their own work to determine the strengths and weaknesses of their work. They could then be given the opportunity to do the work again. Just as businesses are constantly looking for ways to continually improve their product, involving students in the assessment process not only gives them a measure of control over their work, but it helps them to know how to improve their work.

Sixth, instruction should support individual interests and creativity. The "learner-centered" teacher attempts to learn what interests the student have and allow them to work on projects or use classroom resources that target those interests. For example, students who are interested in drama may be able to use this interest as part of a project. Or, students who are interested in and have access to computer technology may be able to use this interest to make computer presentations.

Seventh, instruction should provide positive social interactions and personal relationships. This is a very powerful tool. One example I have seen of this has been in the teaching of mathematics and science. Students often worked in groups on problems and projects. This structure created an atmosphere of "student mentoring" in the classroom. Students have commented that this was very helpful because there are

times when one of their classmates can explain a concept a lot clearer than the teacher.

Finally, instruction should adapt to a variety of individual differences. Teachers need to be sensitive to differences in culture, experiences, abilities, and values that students have. As teachers, we can't assume that all students come into the classroom with the same prior experiences and abilities. As McCombs (2001) points out, the learner's perception of education are "the result of each learner's prior experiences, self-beliefs, and attitudes about schools and learning, as well as their current interests, values and goals." (p. 4) These perceptions form the basis of student needs. And, teachers must be aware of what those needs are and plan teaching/learning strategies that address those needs.

Technology Supported Learning

Now that we've looked at some key issues regarding instruction, let's focus on how technology can support learning. According to the 1999 report, How People Learn, from the National Research Council, technology can be used to help supply five key conditions for learning. These conditions are noted in Figure 2.

The conditions are real-world contexts for learning; connections to outside experts; visualization and analysis tools; scaffolds for problem solving; and opportunities for feedback, reflection and revision. These issues also address the major directions for education recommended by National Council of Educational Reform in 1985 (Harnisch, 1999a, 1999b).

First, technology can support real world context for learning by using simulations, which can form the basis for Project Based Learning. Project Based Learning uses in class projects that are used to cover course content and fulfill certain course objectives. Students have the opportunity to work on the project as teams and report their results to the entire class. One way to do this is through the use of simulation. Simulation exposes students to real-world problems to which they must find solutions. They are looking for answers that are "situation specific" rather than the "right answer" from a textbook (Teaching and Learning, 2001).

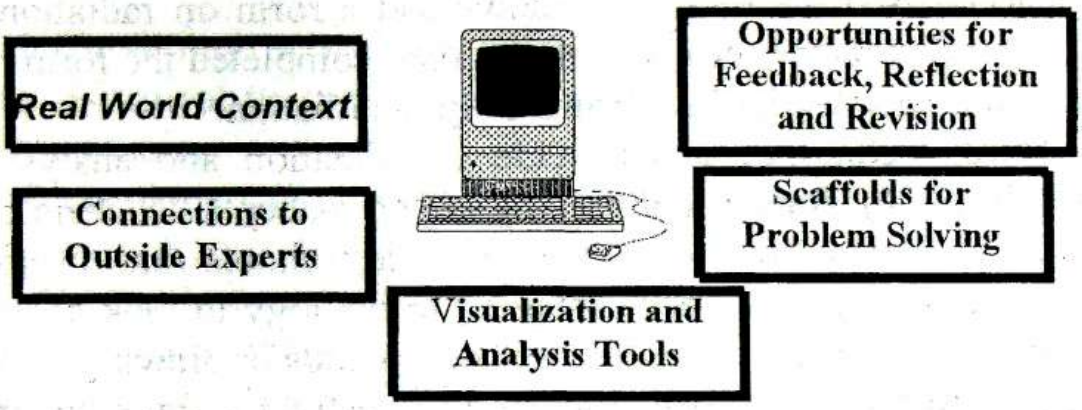

Figure 2: Key Learning Conditions Supported by Technology

When students are doing simulations, they have the opportunity to work on their own. The teacher becomes a facilitator to help them in the process. This addresses the first concern of the Education Reform Council, which is an "increased in emphasis on individuality and encouraging young people to pursue their individual talents and inclinations."

One example I've seen in my own research is using data generated from science classes as in mathematics classes. In one case, students used the distance data generated from throwing softball as the basis for learning about vectors in mathematics. The science data helped the students make a real world connection between science and mathematics.

Second, technology can connect students with outside experts. This addresses a second major direction proposed by the Council of Educational Reform, "planning for an coping with change, particularly in regard to internationalization and the information age." Through the Internet, students can have access to experts in practically any field all over the globe. They can send e-mail to them and even "chat" with them online. In one of my own classes, the students became very excited when they were able to have their questions answered during a "chat" session with a well-known expert in education. Students can also download documents that are not available in the library, and they can keep up with the latest research.

Two examples come to mind. I have seen groups of students who were involved in a simulation exercise that involved a brain disorder use the internet to do research on the disorder and to learn what tests to run to determine what, if any treatment was available. In addition, a chem-

istry teacher used the Internet to download a form on radiation exposure. The students together with the teacher completed the form in class to determine their level of exposure daily to radiation.

Third, technology can provide visualization and analysis tools (Harnisch, 2000). Rather than talking about concepts, teachers can use technology to visualize them. For example, schools that do not have microscopes can use advanced imaging technology to look at the parts of a flower rather then relying on textbook photos or drawings. Also, 3-D imaging allows chemistry students to construct a three-dimensional model of an atom and animate it so they can see it from all sides. In mathematics, graphing calculators can visually show students relationships between variables. Concept mapping using "Inspiration" software can help students visualize processes and relationships.

Fourth, technology can provide scaffolds for problem solving (Harnisch and Sato, 1990). In today's rapidly changing world students need to learn much more than the knowledge written in a textbook. They need to be able to examine complex situations and define solvable problems within them. They are needing to work with multiple sources and media, not just the single textbook. They need to become active learners, and to collaborate and understand the perspectives of others. What we are talking about is the ways in which students today need to learn how to learn; that is, they need to learn how to:

- Ask: find problems
- Investigate: multiple sources/media
- Create: engage actively in learning
- Discuss: collaborate; diverse views
- Reflect: learn how to learn

This shift to an inquiry-based mode of teaching and learning is now widely recognized (Bruce and Davidson, 1996; Minstrell and Van Zee (2000), Shavelson and Towne, 2002; Wells, 2001). The National Science Foundation has asked for "research-validated models (i.e., extended inquiry, problems solving)." The Carnegie Foundation's Boyer Commission on Educating Undergraduates in the Research University (1998) has set its number one priority to make research-based learning the standard. The American Association for the Advancement of Science, in its Project 2061, has as its number one goal to have "science

literacy for all high school graduates," by which they mean to develop the broad, critical perspective and habits of mind that develop through scientific inquiry.

Technology can provide collaboration between students, teachers, and outside experts that help students to solve problems. Through email, discussion boards, and web pages, students have access to educators, and to expert who can help them to think through problems. Also, technology can provide students with problems-solving experiences by developing "Inquiry Units." This is available to both teachers and students through a web site at the University of Illinois at Urbana-Champaign at http://inquiry.uiuc.edu/. The Inquiry Page is more than a web site. It's a dynamic virtual community where inquiry-based education can be discussed, resources and experiences shared, and innovative approaches explored in a collaborative environment. Such as "Web Quests" to help them to develop problem solving skills. Based on John Dewey's philosophy that education begins with the curiosity of the learner, we use a spiral path of inquiry: asking questions, investigating solutions, creating new knowledge as we gather information, discussing our discoveries and experiences, and reflecting on our new-found knowledge. I invite you to visit the inquiry page. There are lessons on life that can be downloaded and adapted for use in your classroom. Also, you can place inquiry units on the page and access them from anywhere in the world. Your students can also develop units as part of a lesson and put them on the page to share with others. By doing this, you will become part of a world-video learning community.

Finally, technology can provide students and teachers with opportunities for feedback, reflection, and revision (Harnisch 1997a, 1997b). This addresses a third direction proposed by the National Council on Educational reform, "to create and enhance educational opportunities for people of all ages (life-long learning)." This can be done through the use of word processing technology and hand-held devices. Word processing allows students to review their documents countless times. Teachers can read an electronic version of documents and indicate areas that can be corrected. Hand-held devices (PDA's) allow the teacher to evaluate a student's work while they are presenting it in the classroom. The teacher can then upload a copy of the evaluation to a computer and

print it for the students or save a copy of the evaluation for their portfolio.

Evaluation of Technology

This brings us to my final point in the presentation of the evaluation of technology. There is a need for small and large-scale studies to evaluate the goals, assumptions, and the uses of technology in the classroom. The studies should focus on how well the uses of classroom technology match the learner-centered principles and practices. The long-term goal is to build schools that are learner-centered communities, which can be done by expanding collaboration and will result in a transformation of the current educational system.

Riel (2001) lists six key characteristics of a "Learning Community." These are a, "shared interest in a topic, task or problem; respect for the diversity of perspectives; a range of skills and abilities; the opportunity and commitment to work as a team; tools for sharing multiple perspectives; and knowledge production as a shared goal or outcome." (p. 8) While technology has an obvious role in building a learning community by expanding collaboration, the role of technology in this process, its role in the process must be grounded in research-validated principles and practices.

McCombs (2001, p. 6) notes the following four essential questions that should be the focus of assessment: 1) How is technology perceived by individuals learners and teachers relative to its teaching-learning support?; 2) What changes in learning and performance outcomes can be observed with different technology uses and with different learners?; 3) What changes in teaching processes can be observed that enhance learning outcomes?; 4) What changes in the learning context can be observed that create new partnerships and climates for learning?

McCombs (2001) also identifies five data sources that can answer these questions. These are student and teacher self-assessments of technology practices and strategies; students and teacher attitudes toward technology and its specific uses; Multiple student motivation measures; Multiple students achievement measures; and Observational information on learning outcomes, teaching and learning context. I

would like to add a sixth, which is student products. While this is related to student achievements, I would like to emphasize that student projects give teachers and other administrators the opportunity to observe the student's ability to apply knowledge to real-world situations.

Technology can also play a role in the collecting of assessment data. For example, surveys can be done online. Student's work can be stored in electronic portfolios that are accessible to teachers through a web browser. Also, teachers can perform "mobile real-time assessments" in the classroom using palm-top computers (Means, Penuel and Quallmalz, 2000). In Figure 3, we present a chart adapted from one produced by the North Central Educational Laboratory that we feel is a helpful tool that can be used to guide you though the planning process.

In conclusion, we must begin to rethink the concept of "school" in our technology rich world. We must not think in terms of seat time, and textbooks, and in school libraries. We must add to our thinking learner-centered collaborative activities that give students the tools and the freedom to explore their world and the tools they need to improve their own learning and develop their knowledge base. In addition, we need to better understand the ways in which technology-supported education represents a melding of the learner and the discipline as framed by inquiry-based learning.

You know, when Sony built the Walkman, they weren't satisfied with being second best. They began to look for ways that they could daily improve their product. Their hard work gave the consumer access to new technology and features. Sony set the standard for portable sound. Just as Sony didn't quit, we as educators should not quit. We should be asking ourselves this question, "What can I do today that will help the students to learn just a little bit better?" It doesn't have to be a big change, but if we do this each day, we will, like Sony, begin to set new standards for education and better prepare our students to live in the 21st century.

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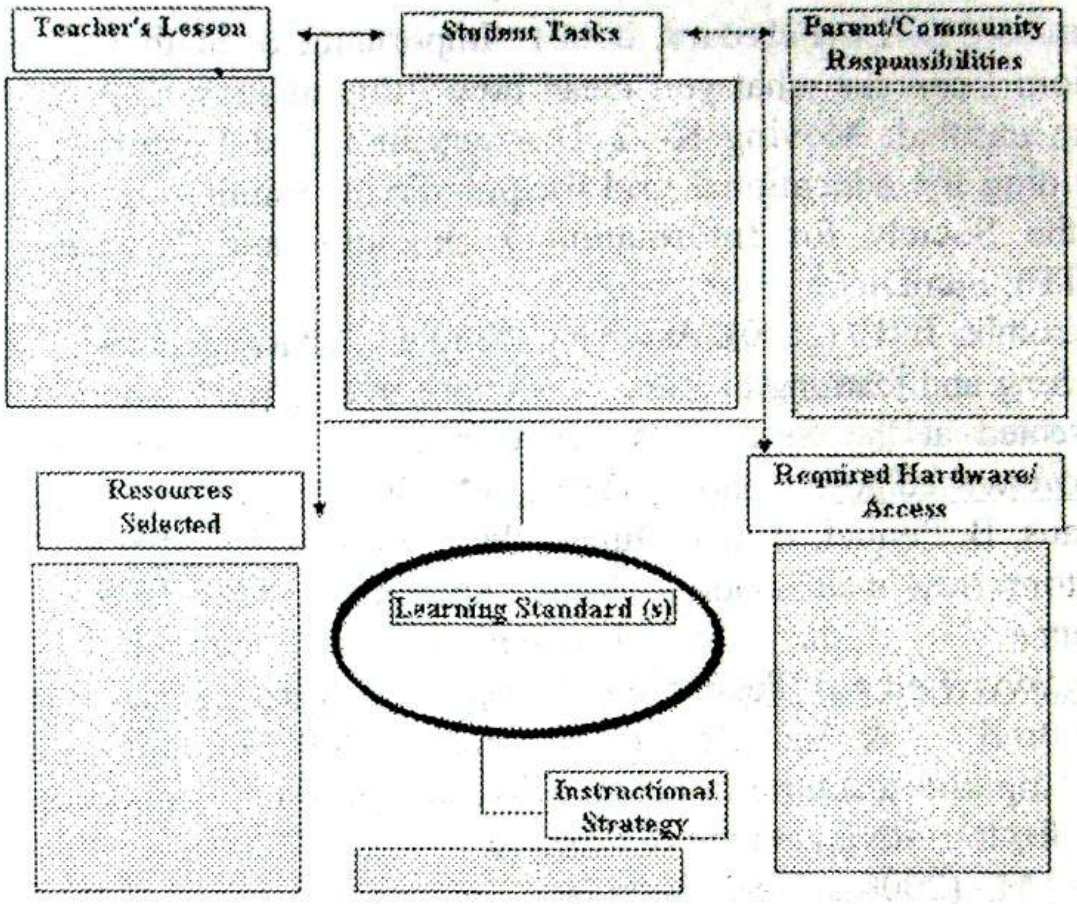

Figure 3: Technology Integration Planning Tool

(Adapted from Technology Connections for School Improvement: Planners' Handbook by M. L. McNabb, G. Valdez, J. Nowakowski , and M. Hawkes. North Central Regional Educational Laboratory, NCREL 1999, p. 115.)

* Стиль та орфографія автора збережені