Russell, D., & Schneiderheinze, A. (2005). Implementing an Innovation Cluster in Educational Settings In Order to Develop Constructivist-Based Learning Environments. *Educational Technology & Society*, 8 (2), 7-15.

Implementing an Innovation Cluster in Educational Settings In Order to Develop Constructivist-Based Learning Environments

Moderator & Sumamrizer:
Donna Russell, Ph.D.
Assistant Professor
Dept. of Curriculum and Instructional Leadership
School of Education, University of Missouri-Kansas City
USA
russelldl@umkc.edu

Art Schneiderheinze, Ph.D.
Project Construct National Center
ASchneid@COLUMBIA.K12.MO.US

Discussion Schedule:
Discussion: February 10-23, 2005
Summing-up: February 24-25, 2005

Pre-Discussion Paper

Abstract

This forum will initiate with a description of the implementation of a constructivist-based reform effort in k-12 classrooms in the US. The reform effort was an online collaboration among four teachers in 4th and 5th grades classrooms to implement a design problem-based unit meant to develop higher-order thinking responses in students. The unit design principles are correlated to current research in the cognitive sciences and the teachers' efforts at implementing reform are correlated to current research in theories of innovation. The initial description will also briefly characterize aspects of the implementation process that led to productive or less productive reform results. The questions that will be developed in this forum include:

1. How can teachers' professional development programs to increase the effectiveness of innovation in education?
2. Do students have a stake in educational reform including emerging technologies-specifically constructivist-based learning principles-, as in are these learning principles important and valid for students?
3. How can educational systems encourage innovation in education?
4. How can communities support efforts to change in education?
5. Are reforms, such as the integration of advanced technologies within a constructivist-based learning environment meant to develop higher-order cognition valued in today's society?
6. How can educational research aid efforts at change in education?

Introduction

This dialog will focus on the design and the goals for implementation of an innovation cluster which includes an online workspace for students and an authentic problem-based unit designed to develop higher-order cognition processes in k-12 students. The topics of consideration in this dialog include the identification of:

1. the productive aspects of collaborative professional development for innovative educators,
2. the characteristics of the online technology used to develop the constructivist-based learning environment,
3. the types and qualities of communications in the teacher's local context that supported innovation.

The Innovation Cluster

The innovation cluster included an emerging technology, Shadow NetWorkspace™ (SNS), and a unit design framework, "Improving Interstate 70", based on constructivist-learning principles. Rogers (1995) suggests that some innovations, usually technology innovations, are better viewed as a cluster, in which the innovations within the cluster share a complementary relationship.

Shadow NetWorkspace™

The 4th and 5th grade teachers used SNS to collaborately design and implement the unit. Their students, as well, collaborated throughout the unit and interacted with experts in related domains using SNS. SNS (Laffey, Musser, & Espinosa, 2000), designed and produced by the Center for Technology Innovations in Education (CITE) at the University of Missouri at Columbia, is a web-based work environment designed and developed specifically for use in K-12 schools to support schools and learning. Shadow was developed at CTIE with support provided by the SBC Foundation, the Missouri Research and Education Network (MOREnet), the University of Missouri System, and the U.S. Department of Education. The operating system for SNS is Red Hat Linux. Since SNS is distributed with an open source license, it is free to all schools. MOREnet served the middleware tool from its server to the schools of the participating teachers.

The goal of the developers of SNS was to develop advanced online tools that make a collaborative learning environment possible for any school. SNS provides shared workspaces for collaboration; discussion boards, chat, email, and messenger systems for communication; and web-based document editors and viewers for representation. A user of SNS gets a personal desktop that allows him or her to use the tools available in SNS including a calendar, homework tool, profile, and word processing tool called Shadowdoc. Any user can create different workgroups, see Figure 3, including a review panel group which allows outside experts to dialog with students through a structured response forum. The students invite the experts in through an email template and then the experts respond through chat or discussion board dialogs. Students and teachers can engage in synchronous dialogs using the chat function in SNS.

The file management system enables a user to upload and store files and media objects in a folder system. Users can create new folders, move and delete folders and files, and search for files within their file system. Group structures enable distribution, and sharing of file objects by its members. Groups are designed around social structures in learning communities and provide a new functionality for the roles within the group. In one particular type of group, review panels, the owner can place items and the other group members (including people from outside the community of users) can view them and leave notes. This creates a potential to offer authentic interactions with experts in the field with whom the students would otherwise not have contact.

SNS served several purposes in the development of the unit. First, the teachers in this study collaborated to design the unit via professional development activities provided by the both Art and me. They took advantage of SNS tools such as a discussion board, file management system, messaging, and chat rooms. Additionally, the students used SNS to facilitate collaboration, communication, and knowledge sharing during the unit. SNS is a closed-community of members that have the ability to form different types of groups. Therefore, the students are capable of working collaboratively online within a safe environment.

The CBLE unit

The unit, "Improving Interstate 70", engages students in tackling a complex, open-ended problem taken from a real-world context. Interstate 70, stretching across 251 miles of Missouri and intersecting almost every major highway that traverses the state, is the most widely used highway in Missouri. The newest stretch of I-70 is nearly 34 years old, and the oldest part is over 43 years old. The Missouri Department of Transportation reports that nearly 200 people are killed in accidents on Missouri interstates each year. Furthermore, much of Interstate 70 is carrying more traffic than it was designed to accommodate. By 2020, with no changes made, traffic on the entire route will far exceed its capacity. The design problem for this unit is the development of the I-70 corridor throughout the state of Missouri.

In this problem-based unit, students from four Missouri schools collaborated to work as engineers to tackle this problem and propose an effective and efficient way to ultimately improve the highway border-to-border in Missouri. Appendix A is the Instructional Design Template for the I-70 Unit distributed to the teachers prior to the initiation of the unit. The goals of the unit were based on the Missouri Show-Me Standards, a set of academic standards that school districts can use to align curriculum and serve as the basis for state-wide assessment on the Missouri Assessment Program (MAP). The standards are based on the idea that "the success of Missouri's students depends on both a solid foundation of knowledge and skills and the ability of students to apply their knowledge and skills to the kinds of problems and decisions they will likely encounter after they graduate" (Missouri Department of Elementary and Secondary Education, ¶1).

The standards are grouped into two sections: performance (process) standards, which identify thinking processes and skills students need in order to acquire, organize, and apply knowledge, and knowledge (content) standards, which identify important content students should learn from their studies in the traditional subject areas. Although the instructional unit in this study incorporates a set of knowledge standards in communication arts, math, science, and social studies, the goals for the unit align closely with the performance standards. The goals for the unit included:

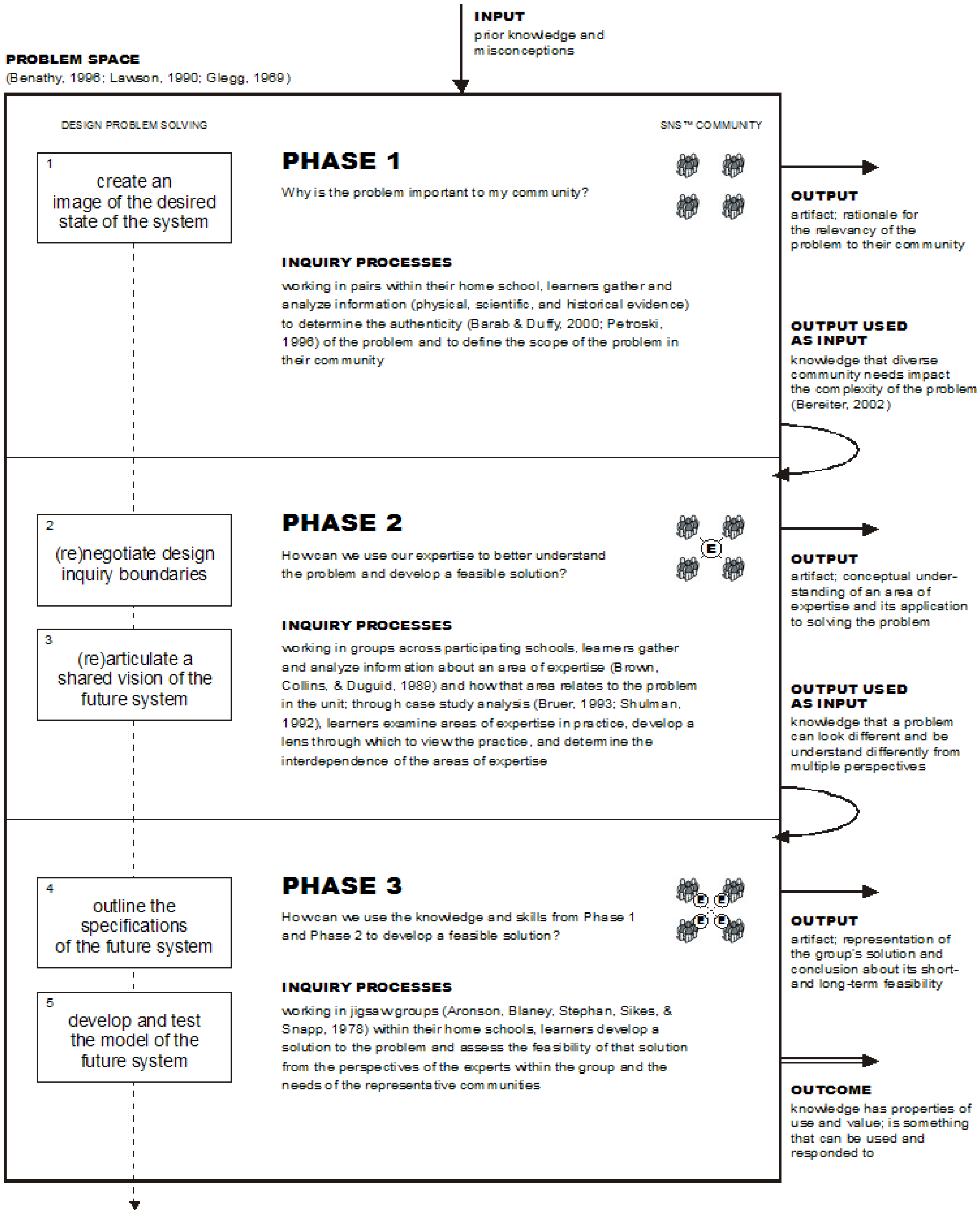
- Working as a researcher exploring transportation systems in Missouri, the student will gather, organize, analyze, and apply information and ideas (Show-Me Performance Standard #1).
- While analyzing potential problems and solutions, the student will communicate effectively within and beyond the classroom (Show-Me Performance Standard #2).
- Using the tools of inquiry to develop a highway improvement plan, the student will recognize and solve problems (Show-Me Performance Standard #3).
- While considering the interdependence of community and state needs, the student will use critical thinking to defend and support his or her decisions (Show-Me Performance Standard #4).
- As an engineer working with other engineers, the student will be a responsible group member and demonstrate positive leadership skills (Show-Me Performance Standard #4).

The unit in this study draws upon the theoretical and practical applications of constructivist learning principles. For the purposes of this study, the researchers identified important concepts based on a constructivist theoretical framework that contributes to the design of this unit. These concepts, within an ill-structured problem-based instructional design method (Jonassen, 2000; Savery & Duffy, 1996) include: scaffolding and mediation (Vygotsky, 1986; Wertsch, 1998), goal-directed (Schank, 1994), meaningful context and inquiry (Lave & Wenger, 1991), and collaboration (Salomon, 1993).

A template of the unit Phases is shown below as Figure 1. The three phases were designed to be developmental and build on previous learning experiences. The design problem is the development of the I-70 corridor throughout the state of Missouri. The ill-structured problem was used as a design topic because the interstate runs across the state and is used by all the communities involved in the study. Phase 1 was designed to aid the students in developing the local issues in the problem. Phase 2 allows the students to develop expertise by communicating with experts. During Phase 3 the students develop solutions and present these solutions to an audience.

Design Problem Solving Model

Drawing upon literature in problem solving, specifically design problem solving, the unit engaged students in authentic processes similar to actual designers. Students can be actively involved in practices directly related to practices of a particular domain rather than passively reading about, hearing about, or merely thinking about those practices as something outside of school (Barab & Duffy, 2000; Lave & Wenger, 1991). First, as suggested by Banathy (1996), design problem solving initially involves a transcending process – a realization that the existing system must be changed as a whole or that a new system must be created. If a system cannot be changed or a system does not already exist, the designer begins a series of transformations from genesis to a model of the future system. Although Banathy (1996) defines the "genesis" as recognizing that a new system is needed, other literature in engineering and graphic design suggests that the designer does not always initiate this process. In fact, a client, who hires the designer to do something, starts this process. This leads to a series of constraints identified that fall on a continuum from most flexible with more degrees of freedom (constraints identified by the designer) to the most rigid (constraints imparted on the designer by a legislative body) with mandatory requirements (Lawson, 1984).While doing this, the design problem solver negotiates the design inquiry boundaries.



Scaffolding

Throughout Phase 1 of the unit, students gathered scientific, historical, and physical evidence from a variety of sources in order to determine why the Interstate 70 problem is important to their community. In the process, students developed a vision of how the Interstate 70 system should meet the needs of people in their community. Working with students from other participating schools, students negotiated design boundaries by understanding concepts important to the design of an interstate highway system (i.e., traffic flow, socioeconomics, design and engineering, public affairs, natural environment, human environment, financing, and constructability). This in-depth research enabled students to activate relevant prior knowledge, identify designer, client, and legislative constraints, and recognize system interactions. With expertise distributed among students from among participating classrooms, students returned to their original groups and began to outline the specifications of the future system, based on their reconstruction of the knowledge acquired from the expert groups and their conceptions of their community and the state's needs for transportation. Depending on the goals of the participating teachers, students might develop a model of the future system to communicate their ideas and defend the idea's feasibility to experts in the field.

Technology

In a problem solving experience, students actively confront ill-structured problems that closely resemble real-world problems. Throughout the experiences, students assume the goal of responding to the problem with a feasible solution based on the knowledge they constructed throughout the unit. Jonassen et al. (1999) suggest that the learning environment includes a problem manipulation space in which students can experiment with the problem and see the results of their experimentation. In addition, students need access to information such as text documents, video, sound, graphics, and so forth to begin making meaning about the problem as well as related cases to represent the complexity of the problem from multiple perspectives. This instructional method requires students to demonstrate a set of skills that extend beyond the mere recitation of facts or correct responses. Fortunately, teachers can support student learning by taking advantage of technology tools that foster cognitive processing and collaboration.

Goal-directed

Throughout the instructional unit, students will work collaboratively to respond to the critical question in each phase of the unit --- in Phase 1, "Why is the Interstate 70 problem important to your community?", in Phase 2, "How can we use our expertise in an area related to Interstate 70 to better understand the problem and develop a feasible solution?", and in Phase 3, "How can we use the knowledge and skills from Phase 1 and Phase 2 to develop a feasible solution to the Interstate 70 problem?". As students work to develop responses to these questions, the teachers will provide ways for students to control the environment in which they learn giving them the opportunity to adapt what is presented to them to their needs, to make choices to direct their learning, and to construct their own understanding of the information. Therefore, according to Schank, Fano, Bell, and Jonassen (1994), the students must find the goals of the unit authentic, and the skills necessary to accomplish those goals must be skills that the teacher wants the students to learn.

Meaningful context

Petraglia (1998) questions teachers' attempts to pre-authenticate constructivist-based learning experiences when inherent in constructivist theory are the ideas that meaning-making is in the mind of the knower and reality is a product of the mind. While making a parallel between rhetoric and constructivist learning, Petraglia suggests "argument as the quintessential constructive process" (p. 128). Consequently, within this framework arguments can draw on prior experiences, prior reasoning frameworks, knowledge of social convictions, and the gathering of relevant information to serve as evidence. (p. 128)

While persuading students to accept the authenticity of an educational task, the teacher can create a sense of the significance of the issue using a variety of data, theoretical frameworks, and lines of reasoning. Embedding skills and knowledge in holistic and realistic contexts also enable students to generate new knowledge and sub-problems as they determine how and when knowledge is used (Cognition and Technology Group at Vanderbilt, 1992). When students conceptualize the learning process as a means of finding a solution or eliciting a response predetermined by the teacher, they will not assume ownership of the learning (Savery & Duffy, 1996; Schoenfield, 1996). The students spend the first phase of the instructional unit determining why the problem in the unit is important to their community. The connection may be initially ambiguous, but the teachers can help to establish the meaningful context by providing students with opportunities to gather information and questioning the relevance of that information to their community and the unit problem. Integrated into this model for design problem solving is also the model used by expert designers and engineers at the Missouri Department of Transportation to propose alternative solutions to the public. Their model created an authentic context for students by closely integrating the design processes used by experts.

Hinrichs (1992) suggests that more experienced designers employ an associated mechanism for drawing on prior experiences and look for similarities between these prior experiences and the current problem. This process, known as case-based reasoning, helps explain a portion of the cognitive processes that designers undergo to propose solutions to problems. Designers store previous experiences with a problem in memory as chunked information known as cases. Cases do not only come from a designer's personal experience but also from documented experiences of others (Garza & Mayer, 1996). When a new problem arises, the designers retrieve elements of cases from prior experience and determine the adaptability of that experience to the new problem. By drawing on previously stored cases, the designer can avoid spending time necessary to derive solutions from scratch and use prior experiences as a means to rationalize the quality of a solution when no algorithmic method for assessment is available (Kolodner & Leake, 1996). Consequently, teachers will provide opportunities for students to analyze case studies (Shulman, 1992) about other projects related to design problem-solving in order to enrich the context for students to apply expertise and identify interrelationships among those areas of expertise.

Inquiry

Through the process of inquiry, students construct much of their understanding of the natural and human-designed worlds. Inquiry implies a "need or want to know" premise. Inquiry is not so much seeking the right answer -- because often there is none -- but rather seeking appropriate resolutions to questions and issues. Although the students are working towards responding to the same critical question in Phase 1, students will generate a series of questions about their community and about the Interstate 70 based on their prior knowledge or naïve theories (Clement, 1993; Resnick, 1983; Mestre, 1987). At the end of Phase 1, the teacher provides the opportunity for students to reflect on the importance of the Interstate 70 problem and determine what areas of expertise should be formed in order to develop a feasible solution to the problem. Throughout the process, the students will access a variety of information resources, including digital resources available on the World Wide Web.

Collaboration

Students develop responses to the critical questions in the unit through collaboration that enables them to distribute the cognitive load among members of the group, take advantage of the groups' distributed expertise, and support individuals to resolve diverse points of view (Evenson & Hmelo, 2000; Brown, 1995; Pea, 1993; Salomon, 1993). Within the unit, students will participate in three different types of collaborative efforts. First, in Phase 1, students worked in groups of two or three students to gather and analyze information about the importance of the Interstate 70 problem to their community. Each small group of students presented their perspective to the other groups in the class, while the teachers facilitated students negotiating multiple perspectives and shared understanding (Bednar et al., 1992; Resnick et al., 1991).

In Phase 2, students formed cross-classroom workgroups based on the areas of expertise they identify as important to solving the Interstate 70 problem. After the four participating classrooms determined the number of areas of expertise to investigate, the teachers divided her students (based on their interest) into the determined number of expert groups. The students, working with students from the other classrooms in the same expert group, collaborated using the SNS network technologies to develop their understanding of the expert area and determine the importance of that expert area to solving the Interstate 70 problem.

In Phase 3, students created collaborative solution groups within their classrooms that consist of students from all of the areas of expertise. The students, who took on various roles in the knowledge building process in Phase 2, will worked with others in a jigsaw format (Aronson et al., 1978) to develop group understanding of each area and of the interdependence of the expert areas. In order for the solution group to develop a feasible solution to the Interstate 70 problem, all of the areas of expertise are important to assess the group's proposed solution.

Conclusions

Constructivist learning theory serves as an epistemology of learning and understanding and suggests that knowledge and meaning are not fixed but instead constructed by the individual within the context of meaningful learning. A constructivist-based learning environment, such as an extended unit focusing on a particular open-ended problem, engages students in meaningful learning through complex, novel, and authentic tasks.

In the Report to the President on the Use of Technology to Strengthen K-12 Education in the United States (1997), the committee of advisors recognized the benefits of a constructivist theoretical framework to student learning and recommended looking more closely at the constructivist pedagogic model and the role of technology within a constructivist curriculum. Instances of constructivist-based learning theories include situated theories of learning (Brown, Collins, & Druguid, 1989: Greeno, 1997; Lave & Wenger, 1991; Roth & Bowen, 1995) and distributed cognition theory (Pea, 1993; Resnick, Levine, & Teasley, 1991; Salomon, 1993), which emphasize how the responses of the learner and the design of the learning environment affect the cognitive development of knowledge in students.

Problem-Based Learning (PBL) is an instructional method that addresses the complex knowledge and skill applications that students will face in the future by participating as problems solvers to tackle complex, ill-structured problems that resemble if not mirror real world problems. PBL proposes that learning experiences that build on the interdependent attributes of meaningful learning including authentic, intentional, active, constructive, and cooperative learning (Jonassen et al., 1999) and involve meaningful application of knowledge and skills. The advanced learning potential incorporated in the design of these types of units with the infusion of technology to support the development of these skills has been shown to be an effective form of innovation in educational research. However, if the development of cble's has been identified as a force of change in education and if new technologies have been shown to develop these types of learning environments, then why are there so few examples of the successful pairing of these innovations?

Questions for Online Forum:

1. How can teachers' professional development programs to increase the effectiveness of innovation in education?
2. Do students have a stake in educational reform including emerging technologies?
3. How can educational systems change to encourage innovation in education?
4. Can communities support efforts to change in education?
5. Are reforms, such as the integration of advanced technologies within a constructivist-based learning environment meant to develop higher-order cognition considered valuable in today's society?
6. How can educational research aid efforts at change in education?

Post-discussion summary

The IFETS dialog that responded to the topic of constructivist learning environments and the impact of technology on the development of these innovative learning environments focused on two main themes: innovation and creativity and the use of technology in educational settings and the societal issues related to reform in education.

Innovation and Technology in Education

In response to the initial questions on innovation in education, Alfred posted with a discussion of past innovators and how technology can develop creativity in students. Brent posted an overview of studies on creativity and asked whether the current educational system can support innovative teachers and the development of creative uses for technology. Dawn posted on the learning benefits of using these technologies to solve real-world problems by allowing students to respond to and structure information. Diane commented on the types of educational contexts that develop innovation and how technologies can impact that process in formal and informal learning environments including a question or whether or not innovative principles mediated by technology are unique to different learning environments. Liz and Niahm dialoged about the potential of multimedia enhanced learning environments to develop creative responses. Bill posted with examples of creativity in several settings including the U.S. Army.

Change in Educational Settings

Several ideas were discussed related to understanding how changes were and could occur in educational settings. August and Mitchell both noted how difficult it is to change educational settings using game theory to discuss the issues of risk and potential inherent in change. Rien posted on how important it is to be aware of how the human and non-human aspects impact the development of innovative learning environments with advanced technologies. Dr. De Hoyos reviewed the collaborative research project with the University of Texas at Austin and the Tecnologico de Monterrey in Mexico City which is studying systemic change processes in higher educational settings. Chew mentioned the difficulties of change in educational settings where creativity is encouraged as an explicit policy by the education ministry but the assessment process is still a rigid and summative program. Art dialoged on the professional development needs of innovative teachers and how these teachers need the ability to resolve conflicts in their work activity that result from their efforts to implement change. Marylu also posted on the support systems need by innovative educators implementing change. Oyeteju and Kenn noted the differences in the ways learning is viewed and knowledge is used in online learning environments.

Conclusions

The common thread that emerged in the postings was a realization of how powerful these new technologies can be when used to develop constructivist learning and how radical the changes must be for them to be used in their most productive ways in educational settings. So much of the system has to be questioned before it can change. Questions such as how do emerging technologies mediate the learning processes, what are the pre-existing concepts of what productive learning is and how it occurs in educational settings and what are the conflicts between them, what is the teacher's role in the change process, and what are the social and cultural norms and expectations for education in relation to change? All of these questions presuppose an open and informed dialog on the process of changing education in response to a changing world. Dialogs such as this IFETS forum which brought together educational experts from all over the world to discuss the potential for new learning technologies in constructivist settings is an important part of the process of conceptualizing the potential. Andrews quote from Gibran is an excellent final thought for this dialog on reform in education, "Progress lies not in enhancing what is, but in advancing toward what will be.

References

Aronson, E., Blaney, N., Stephan, C., Sikes, J., & Snapp, M. (1978). *The Jigsaw classroom*, Beverly Hills, CA: Sage Publications.

Barab, S. A., & Duffy, T. (2000). From practice fields to communities of practice. In D. Jonassen & S. M. Land (Eds.), *Theoretical Foundations of Learning Environments* (pp. 25-56), Mahwah, NJ: Lawrence Erlbaum.

Brown, A. (1995). The advancement of learning. *Educational Researcher, 23* (8), 4-12.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494), Hillsdale, NJ: Erlbaum.

Clement, J. (1993). Using bridging analogies and anchoring intuition to deal with students' preconceptions in physics. *Journal of Research in Science Teaching, 30* (10), 1241-1257.

Greeno, J. G. (1997). On claims that answer the wrong question. *Educational Researcher, 26* (1), 5-17.

Hinrichs, T. R. (1992). *Problem solving in open worlds: A case study in design*, Hillsdale, NJ: Lawrence Erlbaum.

Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). *Learning with technology: A constructivist perspective*, Upper Saddle River, New Jersey: Merrill-Prentice Hall.

Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development, 48* (4), 63-85.

Kolodner, J., & Leake, D. (1996). A Tutorial Introduction to Case-Based Reasoning. In Leake, D. (Ed.), *Case-Based Reasoning: Experiences, Lessons and Future Directions* (pp. 31-65), Menlo Park, CA: AAAI Press.

Laffey, J., Musser, D., & Espinosa, L. (2000). Shadow netWorkspace™ Learning Systems Project. In Kinshuk, Jesshope C., & Okamoto T. (Eds.), *Proceedings of the International Workshop on Advanced Learning Technologies* (pp. 188-189), Los Alamitos, CA: IEEE Computer Society.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*, Cambridge, UK: Cambridge University Press.

Lawson, B. R. (1984). Cognitive studies in architectural design. In N. Cross (Ed.), *Developments in design methodology* (pp. 209-220), NY: Wiley.

Mestre, J. (1987). Why should mathematics and science teachers be interested in cognitive research findings? *Academic Connections, Summer*, 3-5, 8-11.

Missouri Department of Elementary and Secondary Education (1996). *The Missouri Show-Me Standards*, retrieved April 2, 2005, from http://www.dese.state.mo.us/standards/process.html.

Pea, R. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp 47-87). Cambridge, UK: Cambridge University Press.

Petraglia, J. (1998). *Reality by design: The rhetoric and technology of authenticity in education*, Mahwah, NJ: Lawrence Erlbaum.

President's Committee of Advisors on Science and Technology (1997). *Report to the President on the use of technology to strengthen K-12 education in the United States*, Washington, DC.

Resnick, L. B. (1983). Mathematics and Science Learning: A New Conception. *Science, 220,* 477-478.

Resnick, L., Levine, J., & Teasley, S. (Eds.) (1991). *Perspectives on socially shared cognition*, Washington, DC: American Psychological Association.

Rogers, E. M. (1995). Diffusion of innovations (4^{th} Ed.), NY: The Free Press.

Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *Children and Computer Technology, 10* (2), 76-101.

Roth, W. M., & Bowne, G. M. (1995). Knowing and interacting: A study of culture, practices, and resources in a grade 8 open-inquiry science classroom guided by a cognitive apprenticeship metaphor. *Cognition and Instruction. 13* (1), 73-128.

Salomon, G. (1993). No distribution without individuals' cognition: A dynamic interactional view. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations*, NY: Cambridge University Press.

Savery, J. R., & Duffy, T. M. (1996). Problem based learning: An instructional model and its constructivist framework. *Educational Technology, 35* (5), 31-38.

Schank, R. C. (1994). Goal-based scenarios. In R. C. Schank, R. P. Abelson, & E. Langer (Ed.), *Beliefs, reasoning, and decision making: Psycho-logic in honor of Bob Abelson* (pp. 1-32), Hillsdale, NJ: Lawrence Erlbaum Associates.

Schank, R. C., Fano, A., Bell, B., & Jona, M. (1994). The design of goal-based scenarios. *The Journal of the Learning Sciences, 3* (4), 305-345.

Shulman, L. (1992). Toward a pedagogy of cases. In J. H. Shulman (Ed.), *Case methods in teacher education*, NY: Teachers College Press.

Vygotsky, L. (1986). *Thought and language,* Cambridge: The MIT Press.

Wertsch, J. V. (1998). *Mind as action*, NY: Oxford University Press.