# Problem-Based Learning in Online Learning Environments

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**Background for Presentation**

This paper describes an online problem-based course in a graduate program at a School of Education and the quality and types of learning potential for these online learning environments. Online learning environments are an area of rapid growth in many areas of education and have become an especially rapid area of growth in higher education. This presentation deals with the design of an authentic problem-based learning environment in a graduate level university course. The course described below is part of a Masters Degree program at the University of Missouri-Kansas City's School of Education. The course is required to complete a Masters in Curriculum and Instruction with an emphasis on Learning Technologies. The degree program is aligned with the NETS standards for the development of a technology-based program in education. The degree is designed to develop summative competencies in three areas: 1) cognitive processes, 2) instructional design processes, and 3) instructional technologies. The matrix for the development of these summative competencies moves the students through three levels of ability; 1) design, 2) development and 3) implementation as shown below in Figure 1.

| Masters in C and I with an Emphasis on Learning Technologies Program Matrix | | | |
|---|---|---|---|
| Competency Phases | Design | Development | Implementation |
| Cognitive Theory and Technology | Cognition and Technology Online | Assessment with Technology Online | Curriculum Internship The design of a new learning technology program. online |

| Instructional Design and Technology | Instructional Design in the 21st Century | Curriculum and Instructional Technology | Action Research: Implementation of a new technology program. blended |
|---|---|---|---|
| Learning Technologies And Mediational Effects. | Assessing the Role of Technology in Education Online | Development of Learning Technologies Programs online | Culminating Event- Thesis Project: Evaluate research program on technology program and write thesis paper. blended |

**Figure 1**

## Course Description

This course, titled The Development of Technology-Based Programs in Education, was designed to prepare the students to design and implement a variety technology-based programs in education. At the first course dialog the students were asked to choose a topic, a problem, from a list of current technology programs in local educational settings. The students were then grouped according to their choice of problem. The students then worked in their online groups to create the three artifacts required for the course, one for each of the three phases of the Problem-Based Learning Template shown below as figure 2. The course readings were posted in response to their choice of problems and were used as required proof of efficacy of the students' responses to the problem. Additionally all the groups were required to include an independent source of reference.

## Intended Learning Outcomes:

This course is part of a program to develop educators with the capability to design, develop, and evaluate learning technologies into a variety of learning environments. The students researched topics, dialoged in online workgroups, collaboratively wrote proposal papers, presented their final solutions, and evaluated the other group's projects. In this course the learners: 1) designed and developed a plan for implementation of a technology-based program, 2) evaluated the effectiveness of the plan of actions designed in the course.

## Learner Activities

1.  Students in this course designed a strategy to address a problem using a technology-based solution. They will work online in collaborative groups in order to design a plan of action.

2.  The students designed a program for evaluating the effectiveness of the plan of action including a minimum of three references including an independent reference. The potential problems for consideration include:

    1)  Design the online curriculum for a graduate course involving several professors in differing countries.

    2)  Design an online data mining agenda for the SOE NCATE review in 5 years including:

    3)  Design professional development program for new STAR lab at the School of Education including:

    4)  Design presentation for laptop program for SOE.

    5)  Develop a wireless handheld program

    6)  Write a grant for a technology-based solution

    7)  Develop a plan for professional development for a current technology program (example: handhelds being used in a local middle school)

    8)  Technology problem that is suggested by the students

Each group created three artifacts resulting from their online collaboration. Each group studied their problem using Blackboard and presented on the characteristics of the technologies reviewed, studied the affordances and constraints of the technologies, and identified the potential benefits from the addition of these technologies. The three papers required are: 1) Definition of Problem Space:, 2) Identification of Expertise , 3) Design strategy for solution.

**Problem-Based Learning Design Template**

The instructor, Dr. Russell, co-created a Problem-Based Learning Design Template (PBLDT) for use in the design of any problem-based unit, whether online or not. The cognitive theory behind the use of the PBLDT is described below with the PBLDT template shown as Figure 2.


*Constructivism and Knowledge Formation*

Constructivism is a theory of how students acquire knowledge and skills. Unlike prior theories of learning that focused on the passive role of the learner and the student's ability to reproduce behaviors upon a stimulus provided by the teacher (e.g., a close-ended question), proponents of constructivism focus on how students are actively involved in the learning process. Students create meaning by comparing what they already know to new experiences. They either resolve the inconsistency by adapting or assimilating the new knowledge into their existing knowledge. Bruner (1990) called this process "meaning making". In constructivist theory learning is an active and engaged process whereby "students are actively engaged in working at tasks and activities that are authentic to the environment in which they would be used" (Savery & Duffy, 1996, p. 37).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. The work of Dewey, Piaget, Bruner, and Vygotsky provide a historical framework for understanding the theoretical assumptions of constructivism and placing this theory of learning within a human action framework of sociocultural theory. These four assumptions include:

1.  knowledge and meaning are constructed, not dispensed, when students are engaged in meaningful activity;

2.  knowledge is anchored and indexed by the context in which the learning activity occurs and requires articulation, expression, or representation;

3.  meaning making, which is prompted by a problem, is an attempt to resolve questions, confusion, disagreement, or dissonance, in the mind of the knower

4.  meaning making and thinking are distributed throughout our tools, culture, and community and may also be socially constructed with others through activities such as conversation (Vygotsky, 1978; Honebein, Duffy, & Fishman, 1993; Jonassen, Peck, & Wilson, 1999).

Research in constructivist learning environments suggests that instructional design grounded in constructivist principles engaged students in purposeful activity as the students attempt to tackle a complex problem, overcome an obstacle, or negotiate a contradiction in their thinking (von Glasersfeld, 1998). In addition, instructional design based on constructivist learning principles allows students to apply their knowledge more effectively under appropriate conditions (Collins, 1991). Teachers present students with a complex problem. Through the process of responding to that problem, students acquire knowledge and skill that enable them to revise their theories, develop new theories, and compare their theories with other students through discussions. When students have the opportunity to articulate what they have learned and reflect on the process they went through and the knowledge they acquired in that process, they understand more and are better able to use that knowledge in new situations. Jonassen et al. (1999) refer to this as intentional learning since students are focusing their learning on satisfying their personal goals. Instances of constructivist-based learning theories include situated theories of learning (Brown, Collins, & Druguid, 1989: Greeno, 1997; Lave & Wenger, 1991; Roschelle & Clancey, 1992; 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.

One of the tenets of PBL is that it is difficult to give meaning to knowledge once it is removed out of context. PBL immerses the students in a context similar to the one the problem would normally occur outside the classroom. The students additionally can consider themselves active members of their community of students within the context of the problem but respond with less risk and intensity than those in actual practice, a phenomena Lave and Wenger (1991) called legitimate peripheral participation (LPP). This contrasts with methods traditionally used for school-based learning that often encourage individual performance, foster unaided thought, cultivate symbolic thinking, and teach only general skills and knowledge (Resnick, 1987). These abstract conditions typically found in traditional classrooms may actually inhibit the development of advanced cognitive skills and the use of school-based knowledge and skills at a later time

(Resnick, 1987; Spiro et al., 1988). Teachers provide cultural tools to mediate the acquisition of knowledge and skills in the pursuit of deeper understanding and higher-order thinking.

Problem solving is an intrinsically human activity. From infancy, humans persist with solving a variety of well-structured and ill-structured problems not only because they strive to overcome failure but also because understanding solving a problem successfully is intrinsically motivating (Bransford, Brown, & Cockring, 1999). Problem solving in education is not a radically new idea. Traditional schoolwork sometimes includes specific incidences where students are asked to respond to a problem in which they apply or represent in a different way the knowledge they acquired during a learning experience. However, the problem solving experience in isolation from authentic context can result in low motivation, low transferability, and rapid forgetting (Bereiter & Scardamalia, 1996).

The unit framework designed for this study incorporates many of the concepts of constructivist-based learning environment (CBLE). The overall thrust of the unit involves students' response to one particular type of problem, a design problem. Although the literature varies in identifying the unique characteristics of design problems, all agree that the design of the problem should involve an ill-structured perhaps even "wicked" complexity (Rittel, 1984). This complexity stems from the uncertainty of the solution path, the subjectivity in how the problem is interpreted, and the blurred boundaries of interacting systems.

In the Problem-Based Learning Design Template (PBLDT) shown below as Figure 2, Phase 1 provides a means for engaging the learner in the relevance of the dilemma to begin challenging the students to recognize the legitimacy of the dilemma (Barab & Duffy, 2000) and develop a local context for the issues. It is through this process that the students develop problems within the topic to research. This phase is an initial questioning phase to develop relevancy and encourage the student interactions. Phase 1 asks the question: "Why is this problem important to us?"

In Phase 2 the students work to develop an area of expertise within their inquiry process. They work in groups that will interface using Blackboard's synchronous and asynchronous dialogic methods. This method of collaborative learning is supported by research on the nature of developing conceptual understanding of complex issues (Bruer, 1993; Brown & Campione, 1994; Brown, Ash, Rutherford, Nakagawa, Gordon, & Campione, 1993; Palinscar & Brown, 1984). In this phase the learner is responding to a wider issue: How do other people, the outside experts and the other classrooms, perceive and attempt to solve problems?

As the students prepare to present their solution to the problem they will come together in local classroom groups in Phase 3. This final phase is based on research on developing community of learners (Brown & Campione, 1990; Brown, Ash, Rutherford, Nakagawa, Gordon & Campoine, 1994).These groups are comprised of students from each area of expertise. Each student has some aspect of the necessary information for the final solution process. This group interaction is called a Jigsaw (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978). This process is also supported by research on the nature of apprenticeship and expertise (Brown, Collins & Duguid, 1989). In this final phases learners are asked to bring together the areas of expertise and respond to the problem by identifying a justifiable course of action or a step-by-step plan of action.

Each phase of this design problem solving unit has aspects of research in cognition built into the instructional process. This design concept encompasses the learner and the teacher into a model that signals "that learning should be viewed as a process of becoming a part of a greater whole" (Sfard, 1998, p. 6). Duschl, (1992) maintains that humans construct knowledge actively through confrontation with a new question, problem, or phenomenon, gathering information, and creating explanations.

**Summary of Course Results**

In the online course, The Development of Technology-Based Programs in Education, the students chose two problems to pursue, 1) the development of a professional development program for the implementation of handhelds in a local middle school, and 2) the development of a curriculum and an evaluation process for an international online course taught collaboratively among two universities, one in the US and one in Sweden. The students developed the artifacts for the three faces producing a final document, their plan of action and rationale, as a result. As a result of the course, the students requested a summer curriculum internship course during which they could further develop their programs. The students that designed a professional development program for handhelds used their summer internship to prepare a presentation to administrators at the local district and a presentation to the UMKC Continuing Education program director for the potential for teachers to receive continuing education credits for participating in their professional development program. The students that initiated a study of the online international course used the summer internship to complete their curriculum model for proposed revision by the professors. They also continued their research into the dialogs among the international students.

The process of teaching online can be constructivist and can be productive based on theories of constructivist learning. The students in this course developed the types and qualities of knowledge that are valued in their future fields. They also envisioned the course as having value beyond the semester and asked for a continuation of the course into the following semester. They also realized these abilities and concepts working in online collaborative groups. The design of problem-based learning units in online learning environments is an important aspect of design and development as many new courses and degrees go online in higher-education. The questions being asked with the influx of online courses should include 1) what is the quality of the knowledge resulting from these courses? 2) how can productive online dialogs be supported? 3) what are the models of design for productive constructivist-based learning environments online?
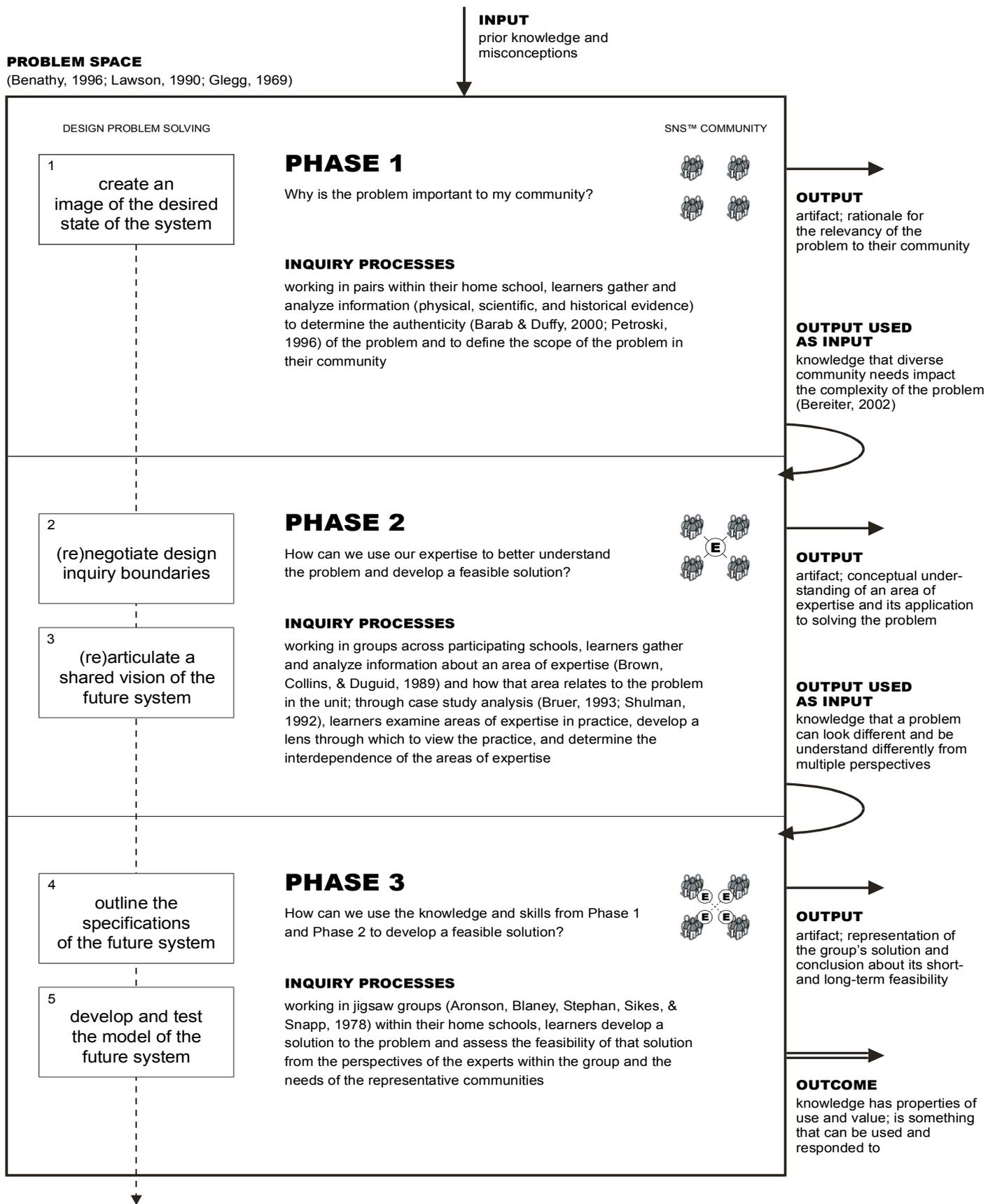
**INPUT**
prior knowledge and
misconceptions

**PROBLEM SPACE**
(Benathy, 1996; Lawson, 1990; Glegg, 1969)

DESIGN PROBLEM SOLVING

SNS™ COMMUNITY

| 1 |
| create an image of the desired state of the system |

# PHASE 1

Why is the problem important to my community?

**INQUIRY PROCESSES**

working in pairs within their home school, learners gather and analyze information (physical, scientific, and historical evidence) to determine the authenticity (Barab & Duffy, 2000; Petroski, 1996) of the problem and to define the scope of the problem in their community

**OUTPUT**
artifact; rationale for the relevancy of the problem to their community

**OUTPUT USED AS INPUT**
knowledge that diverse community needs impact the complexity of the problem (Bereiter, 2002)

| 2 |
| (re)negotiate design inquiry boundaries |

# PHASE 2

How can we use our expertise to better understand the problem and develop a feasible solution?

| 3 |
| (re)articulate a shared vision of the future system |

**INQUIRY PROCESSES**

working in groups across participating schools, learners gather and analyze information about an area of expertise (Brown, Collins, & Duguid, 1989) and how that area relates to the problem in the unit; through case study analysis (Bruer, 1993; Shulman, 1992), learners examine areas of expertise in practice, develop a lens through which to view the practice, and determine the interdependence of the areas of expertise

**OUTPUT**
artifact; conceptual understanding of an area of expertise and its application to solving the problem

**OUTPUT USED AS INPUT**
knowledge that a problem can look different and be understand differently from multiple perspectives

| 4 |
| outline the specifications of the future system |

# PHASE 3

How can we use the knowledge and skills from Phase 1 and Phase 2 to develop a feasible solution?

| 5 |
| develop and test the model of the future system |

**INQUIRY PROCESSES**

working in jigsaw groups (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978) within their home schools, learners develop a solution to the problem and assess the feasibility of that solution from the perspectives of the experts within the group and the needs of the representative communities

**OUTPUT**
artifact; representation of the group's solution and conclusion about its short- and long-term feasibility

**OUTCOME**
knowledge has properties of use and value; is something that can be used and responded to

**Figure 2**

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