Project-based Learning in Undergraduate Educational Technology

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Abstract
Educators encounter complex and ill-defined problems within unpredictable contexts. Teacher education increasingly relies on problem-based and project-based learning. Technology-using educators face added complexities and possibilities of educational technology. The approach to project-based learning (PBL) in educational technology described in this paper is project-centered performance in the educational technology course required of preservice teachers. Students in the course learned through stages of entry, exploration, expansion, evaluation and explanation to formulate a response to an educational problem with a technology-based teaching unit. Instructionally, students demonstrated their mastery of several technology skills and information literacy skills by producing and presenting a complete WebQuest designed for a specific learning need. This paper presents the theory and history of problem-based and project-based learning, its application in educational technology, and data from a study comparing students learning with and without the project-based methods.

The Nature of Educational Technology in Florida's Preservice Education Programs

Educators encounter complex and ill-defined problems of human behavior and learning, and then respond to the problems within unpredictable contexts. Technology-using educators face the same problems, with the added complexities and possibilities of educational technology. A challenge for teacher educators is preparing students to assume the role of the teacher in classrooms that shift in response to outside political, social, economic and community forces, and are populated with students whose needs change by the minute. Teacher educators strive to bring as much "reality education" to their students as they can, enabling students to experience the widest possible range of educational problems and situations. Teacher preparation includes classroom observation, case study, child study, micro-teaching, and field experience, among others. Project-based learning (PBL) has begun to join the agenda. Proficient beginning teachers leave their professional education with a rich repertoire of strategies to employ in their classrooms, and PBL is an approach that can enhance strengthen their repertoire.

An essential experience for educators is learning to use computer technology for teaching and learning. In Florida's state university system, students in education programs leading to initial teaching certification take a required educational technology course as prerequisite for acceptance as an education major. Undergraduate programs include the sophomore level Introduction to Educational Technology. The course has twin goals: building student skills as technology users, and providing background for students to become integrators of technology into teaching. The beginning course in educational technology, mandated by the state of Florida in 1996, is critical in the education of preservice teachers because it is the only required technology course. Each course is a three-semester hour class combining students from all education majors and all specializations. The course includes the following topics: educational hardware, application software, multimedia, Internet, and ethical and legal issues. Web sites and conference presentations confirm that there are multiple approaches to teaching this course, with most variation focused on delivery: fully face-to-face, blended with distance education components, or fully delivered electronically.

At the University of North Florida, the Introduction to Educational Technology course has been taught historically using a traditional approach that taught discrete technology skills, largely in isolation from each other. A new approach integrates all of the skills and their integration into education under the umbrella of a project. The project-based approach is in its second term of implementation here.

Project-Based Learning in Teacher Education

Both project-based learning and problem-based learning are currently employed the teacher education. While problem-based learning began in adult education, project-based learning had its start at the K-12 level. Both approaches engage students in authentic tasks in which they explore open-ended professional situations, and both approaches involve long-term immersion in work that is often collaborative. In addition, both approaches value multiple sources of information and performance assessment (Esch, C. 1998). However, there are fundamental differences between the approaches. As its name indicates, problem-based learning requires students to use an

inquiry approach to solve a complex, realistic problem. Students present their conclusions, which may or may not include a solution. Problem-based learning is at its core a process-oriented experience. In contrast, the goal of project-based learning is creation of a product or artifact. Project-based learning leads students through project development stages that are meant to reflect real-world practices. The knowledge, skills and dispositions acquired in the process are equal in value to the end result itself. As stated by Cunningham (1992), the test of whether someone can complete a task is the task completion itself.

Foundations of Project-Based Learning

The nature of project-based learning (PBL) is developing skills and content by engaging in logical tasks that involve the skills and content to be learned, have personal relevance for students, and provide real-world context for learning (Warlick, D. 1999). Project-based learning is an instantiation of education theory, research and practice in constructivism. The constructivist view considers what real people in a knowledge domain and in a real-life context typically do (Bednar, A., Cunningham, D., Duffy, T., Perry, J., 1992), and PBL guides students to assume a real-life role and apply the tools of a knowledge domain in creating a project. PBL provides a context in which students move toward thinking as an expert in the knowledge domain might think.

Basic foundations of constructivism are situated cognition, cognitive apprenticeship and multiple perspectives, all of which are incorporated into project-based learning. Situated cognition is a form of thinking that is anchored in real-world contexts. Learning of content is embedded in the use of the content. In PBL, students learn content knowledge, skills and dispositions in the process of creating an authentic, realistic project modeled on a project an expert or professional might create. Cognitive apprenticeship is a teaching approach in which teachers model the processes students are learning, and teachers coach students toward expert performance. The essence of project-based learning is its student-centeredness, with students as actors and teachers as directors on an authentically-decorated stage. Learning using multiple perspectives means students draw from many examples of performance, evaluate and synthesize information from many sources, and incorporate alternative viewpoints. Because of the complex nature of the projects accomplished in project-based learning, multiple perspectives not only add to the realism of the experience, but are necessary to complete the project.

The projects designed by students in project-based learning are intended to have meaning in light of the students' long-term goals. To maximize the relevance or meaning of learning, it must be:

- Active-- interacting, manipulating, observing, interpreting and constructing,
- Constructive-- integrating new experiences and prior knowledge,
- Intentional-- articulating ideas, decisions, strategies and solutions,
- Authentic—situated in real-world tasks, and
- Cooperative—occurring in social groups (Jonassen, D. 2000).

Project-based learning environments fit each of these criteria, whether they appear at K-12 levels or in higher education.

Project-Based Learning in Higher Education

Project-based learning at universities arose in the 1970s in Europe, based on the idea that the best form of professional development is learning by doing (Von Kotz, A. & Cooper, L. 2000). PBL has been used in adult education programs at many institutions. At the Leuven Catholic University in Belgium, Social Pedagogy students have been offered a project-based option in which they analyze a problem and plan a project related to the problem in conjunction with community organizations as if they were consultants accepting a bid to complete the work. The projects grew in five phases: selecting topics and forming groups, project planning and presentation of plans, regular planning meetings, presentation of outcome, and evaluation of results. Students were encouraged to approach the projects in an interdisciplinary way, and to embrace unpredictable events in learning.

For teachers in particular, project-based learning has the potential to support specific learning goals while serving as an induction process that models for teachers how they can teach children using a project-based approach. Benefits of project-based learning for teachers include:

- Gaining knowledge across the domains of child development, learning theory, curriculum, community relations, assessment, and professionalism,
- Learning to integrate information in meaningful ways to create similar learning experiences for children,
- Multiple opportunities to practice collaboration while working,
- Strengthening dispositions desired of professional educators through autonomous work (DeJong, L. 1999).

DeJong implemented a project-based approach with her university early childhood education students. They used a three-stage model: orientation to the project and brainstorming ideas, investigating the topic using multiple sources of information, and developing final products. The project findings were presented and assessed at the end of the term.

Project-Based Learning in Educational Technology
In professional development of educators, the Challenge Multimedia Project guided teachers through classroom-based technology integration projects (Cohe, K. 2000). The model was shown to be successful in building technology skills, pedagogy and leadership among participating teachers.

A qualitative study of preservice teachers taking an undergraduate educational technology course at the University of Oklahoma found that students developing projects on the telecommunications topic developed sophistication in using the web, and learned about a new technology through the project-development process (Land, S. & Greene, B. 2000). After learning the basic Internet skills through direct instruction, the students used think-aloud procedures while searching the web and generating project ideas. They spent time sharing ideas while working on the project, then presented projects to the class.

Students in integrated elementary teaching methods courses at Elon University were taught project-based methods in a study designed to discover whether PBL increased the likelihood that teachers would apply their learning in classroom situations (Howard, J. 2002). The students completed a project consisting of developing and teaching technology-enhanced units of instruction. Data showed that the longer students were involved in technology-enhanced project-based learning, the more likely they were to include technology in their own teaching.

The Project-Based Introduction to Educational Technology Course

The Values Underlying the Design of the Introduction to Educational Technology Course
Because it is the only formal required learning experience in educational technology for teacher education students, the Introduction to Educational Technology course serves a wide variety of student needs and program needs. The students arrive with a range of technology abilities and education experiences. The student population includes traditional full-time students who are recent high school graduates, older students who are returning to college after child-rearing or a career change, and retirees seeking enrichment or a second career. The course goals are two-fold: to develop knowledge skills and dispositions of technology-users; and to develop knowledge, skills and dispositions of educators who integrate technology into the teaching of their subject matter.

The instructional philosophies behind the course have led to teaching methods well-supported by project-based learning. Course instructors and designers believe in the value of opportunities for structured reflection throughout the course. Reflection is enabled through online discussion and a developmental portfolio. Hands-on, minds-on learning is an approach practiced during every instructional session, and it develops through the term of the course from being more instructor-driven at the beginning to being heavily student-driven at the end. The technology skills taught in the course are introduced at developmentally appropriate times so complex skills may build on basic skills, and basic skills are reinforced.

The course objectives were developed to meet the requirements of state school law, national accrediting bodies, and professional standards-setting bodies. Course objectives are correlated to Florida Educator Accomplished Practices (AP), National Council for Accreditation of Teacher Education (NCATE) standards, and International Society for Technology in Education National Educational Technology Standards for Teachers (ISTE NETS-T).

Implementation of Project-Based Learning
The students in the educational technology course completed a semester-long project which was a WebQuest that met K-12 standards in a content area such as math, science, or social studies. Each skill that students learned in the course was a step in the development of the WebQuest. A WebQuest is a web-based inquiry-oriented activity in which much of the information used by learners comes from the web. WebQuests teach learners how to use information in learning that involves higher level skills such as analysis, synthesis, and evaluation. Components shared by WebQuests are Introduction, Tasks, Processes, Resources, Evaluation, and Conclusion. Examples of WebQuests can be seen at http://webquest.sdsu.edu/matrix.html. Each technology skill was evaluated using a rubric, as was the complete WebQuest project. Because development of a WebQuest is a complex task, and it is a task that

requires subject-matter knowledge, understanding of teaching and learning, and a toolbox of well-developed technology skills, it is an ideal project for educational technology students. When students completed the WebQuest project, they had evidence of essential technology skills, they had deep knowledge of an aspect of a content area, they had experience tailoring instruction to meet grade level standards, and they had a product they can use as teachers. Learning to create a WebQuest was a five-stage experience: Entry, Exploration, Expansion, Evaluation, and Explanation.

Entry. Students first beginning the educational technology course are new to education, to many aspects of technology, and to the idea of WebQuests. The first three weeks of the 16-week course provide an overview of technology in education, including reading, discussion, video case analysis, and writing about the importance of technology in education and best practice. After refining their Internet and web-searching skills, students read several WebQuests written by practicing teachers and participate in feature analysis and evaluation of WebQuests in order to learn the structure of WebQuests and to think about what makes an effective WebQuest. Students also studied learning theory appropriate to educational technology and included discussion of theory in their WebQuest evaluations. As a job aid, an online WebQuest planning survey was completed by the students. The survey, called The WebQuestinator, is a form that asks students to indicate a grade level, subject area, topic, and possible activity that might be included in their WebQuests. The form returned to the students a narrative outlining basic steps in continuing the development of the WebQuest project.

Exploration. The fourth, fifth and sixth weeks of the term were spent exploring resources in order to narrow down the topics on which the students focused in developing their WebQuests, and acquiring ideas and materials to use in the WebQuest. Students learned to use and evaluate educational software including concept mapping software, and they created concept maps of their WebQuest content. Students studied the technology and subject matter standards for K-12 to identify the standards they would address in their WebQuests. Students also identified and evaluated a group of websites related to their WebQuest topic to decide on websites they would include. To begin learning about the process of teaching, planning for teaching, and the details of teaching with technology, students completed a TechTeach assignment. TechTeach required students to conduct an informal needs analysis to determine a technology skill needed by an acquaintance or relative, and to document the teaching and learning stages experienced by the student as teacher and by the learner.

Expansion. Weeks 7-14 of the term were devoted to skill development and WebQuest creation.

- While practicing, expanding and demonstrating word processing skills, students wrote a plan for their WebQuest, including the Tasks, Processes and Evaluation methods they planned to use.
- Spreadsheet skills were developed in the process of refining the plan for grading work on WebQuest tasks.
- Database abilities were built while compiling a set of web sites evaluated for use in the WebQuest.
- The multimedia assignments required students to edit or develop audio, video and image files for use in their WebQuests.
- The presentation that students developed was designed to serve as an introductory overview of the WebQuest, and possibly to become a component of the WebQuest.
- Finally, web page development skills were built in the process of creating web pages for each component of the WebQuest.

Evaluation. At each step of development, students received instructor feedback on both their level of accomplishment in each technology and their progress on the WebQuest. Students also received peer review at several stages of the development of the WebQuest. When the WebQuest was completed, students completed a self-evaluation using a rubric for evaluating WebQuests.

Explanation. Upon completion of their WebQuest projects, students published their projects online and presented their projects to the class. The presentation stage allowed students to communicate their work to others, and made students aware of the many strategies employed by their peers technologically and pedagogically. During the project process, students became subject matter experts in one aspect of their content area, and the presentation gave them the chance to teach what they had learned. Students watching the presentations offered comments on the features of the WebQuests they liked and asked questions and offered suggestions for enhancing the WebQuest. Figures 1 and 2 are examples from student-created WebQuests.

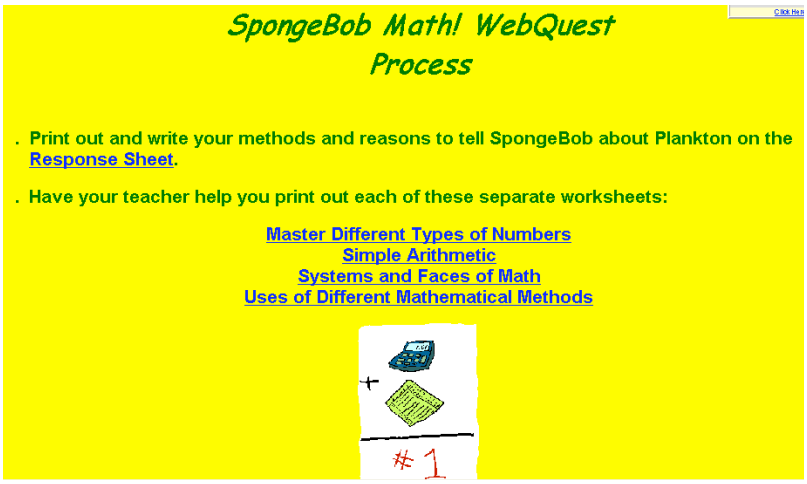

Figure 1. Student WebQuest Evaluation Page

Figure 2. Student WebQuest Task Page

Effectiveness of Project-Based Learning in Educational Technology

The success of the project-based approach in the Introduction to Educational Technology course was judged in several ways. Instructor observation of student investment and attitude during the course indicated that students were more involved in the activities and the class sessions, and placed more meaning on their assignments because the assignments built toward the project. Students' written comments provided further evidence of the success of PBL in the course:

> This semester has changed the way I work and learn using technology. I have learned so much about technology, and I am very comfortable teaching it. I realized that it helps me learn things in a better manner. The most significant change I have experienced is making web pages. I never would have thought that I would be able to create one. This helps me because now that I know I can do something that I never thought I could do, it makes me want to learn more things that I never thought I could to do.
>
> Having all of our lessons leading up to the WebQuest was a great way to learn all these new programs. I intend to incorporate WebQuests into my lessons as

> much as possible. I am crazy for cooperative learning and I think that this is a great way for students to work together to complete lessons.

The effectiveness of PBL in the course was more formally evaluated using two quantitative measures. Student satisfaction with the course as shown in university course evaluation instruments was compared during the semester before PBL was implemented and during the first semester of PBL implementation. In addition, students both semesters were given pre- and post-course surveys to assess their level of technology skill and their attitude toward technology. Apart from the project-based approach, the courses were taught to similar groups of students, using the same assignments and materials, by the same instructor, in the same room and schedule. During the Pre-PBL semester, 39 students took the course and rated the course an average of 4.67 on a scale from 0 to 5. In the PBL semester, 33 students took the course, and rated it an average of 4.78 on the same scale, a small but significant improvement ($p<0.05$). At the time of this writing the post-course skill and attitude survey data are not available for the PBL students.

Conclusion and Recommendations

Project-based learning has been shown to positively contribute to teacher education in several areas of the teacher education program, including early childhood education, adult education, and educational technology. The need remains for exploration of project-based approaches in other areas of teacher education and higher education as well. As PBL enhances preservice teacher learning, its greater value may be in preparing teachers to teach children using project-based methods. Approximately ten years of studies have been conducted studying PBL at the K-12 level, with positive results (Thomas, J. 2000). For higher education students, project-based learning addresses much of what we are learning about effective brain-based learning, including learning with understanding, building on pre-existing knowledge, learning actively, transfer of learning to applied situations, and integration of technology to support learning (National Research Council, 1999).

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