In-Service Teacher Development for Fostering Problem-Based Integration of Technology

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Abstract: This paper reports on professional development approach, used in an Indiana-based Technology Innovation Challenge Grant, for middle and high school teachers designed to promote problem-centered uses of technology. As an initial activity, in-service teachers, pre-service teachers, and grade 6-12 students took part in a two-day modeling activity using technology to investigate and report on a local community problem. This allowed teachers to experience problem-based learning and understand the elements of the process. Evaluation of the modeling activity showed positive reactions from both teachers and students. Subsequently, teachers took part in a semester-long, school-based course involving a number of problem-centered activities. Teachers developed their own problem-centered projects that contained appropriate elements of problem-based learning. These findings suggest that the professional development approach used in this project was effective.

Introduction

Fast-paced life in the 21st century will demand adaptability, problem-solving, and continual learning. A recent Presidential panel report (Panel on Educational Technology, 1997) stated that 21st century workers must possess "the capacity to readily acquire new knowledge, to solve new problems, and to employ creativity and critical thinking in the design of new approaches to existing problems" (p 6). Because of these demands, there is growing emphasis in educational reform efforts on learning models based on students’ active construction of knowledge and skills. Learners must learn how to learn if they are to be successful in a rapidly changing world.

Two similar learning models, problem-based learning (Torp & Sage, 1998) and project-based learning (Krajcik, Czerniak, & Berger, 1999), embrace this perspective on students’ construction of understanding and
show great promise for helping learners acquire knowledge and skills while using technology as an authentic tool. Although the specifics of problem- and project-based learning vary somewhat, they share an emphasis on situated learning (Brown, Collins, & Duguid, 1991) in authentic contexts (Stepien & Gallagher, 1993). Authentic problems anchor the curriculum and provide a vehicle for both problem-solving and content learning. In general, this approach is characterized by: (1) use of an ill-structured problem or driving question that provides opportunities for student investigations and problem-solving; (2) student analysis of the overarching problem or question to identify a specific problem for investigation (e.g., identifying what is known and unknown); (3) student-conducted investigations or actions that typically result in the development of artifacts or products; (4) collaboration among students, teacher, and community; and (5) student presentation of a final report or solution that summarizes the process and findings. Technology can play an integral role throughout this process as a tool for acquiring relevant information, gathering and manipulating data, and producing and presenting the culminating presentation in multimedia format.

For teacher educators, a key issue is how to best help in-service and pre-service teachers learn to apply problem-based methods that effectively integrate technology. Little (1993) argued that traditional models of professional development are not adequate to the task of preparing teachers for the challenges of teaching in the climate of reform. Because of the complexities of pedagogies demanded by learner-centered approaches, deeper and more meaningful professional development experiences are needed. One-shot technology workshops will not work today (if indeed they ever did). The Indiana Education Policy Center (1996) suggested that, to provide for continuous growth, effective professional development must: be school-based, use coaching and follow-up techniques, be collaborative, focus on student learning and be evaluated at least in part on that basis, and be embedded in the daily lives of teachers. Hill (1999) suggested that teacher technology development can rely on the same problem-centered and activity-based methods that are suggested for students in problem- or project-based learning.

This paper reports on the initial professional development activities of an Indiana-based Technology Innovation Challenge Grant project. These professional development activities, launched in the fall of 2000, were conducted by university faculty working in collaboration with teachers from the lead school district. Activities relied on problem-centered approaches to introduce problem-based learning with technology. The goals of the in-service professional development were to: (1) promote teachers’ understanding of problem-based learning, (2) facilitate teacher’s development of technology integration skills and knowledge, and (3) facilitate teachers’ development and implementation of their own problem-based learning activities incorporating technology. The process consisted of an initial problem-based learning modeling activity, designed to show teachers the problem-based method in action, followed by a semester-long, on-site course focused on technology integration and problem-based learning approaches. The process and preliminary outcomes are described here.

**Project Background and In-Service Professional Development**

**Tech-Know-Build: Indiana Students Building Knowledge with Technology** is a Technology Innovation Challenge Grant project, funded by the U.S. Department of Education, which deals with problem-based learning approaches integrating the use of technology. Initiated in August of 2000, this five-year project focuses on the development and implementation of a learner-centered and problem-based curriculum, beginning in the sixth grade, involving collaborative construction of knowledge in authentic contexts using technology. Naturally, professional development is an important element of this process. Additional elements of the project include the use of portable technologies, electronic mentoring of K-12 students by university pre-service teachers, and electronic links among project partners and with the larger community. Project partners include the Crawfordsville (Indiana) Community Schools, Indianapolis Public Schools, Purdue University, and Indiana University Purdue University at Indianapolis (IUPUI).

The university partners, working closely with school personnel, direct the teacher professional development component of the project. Purdue University (main campus) has a long history of cooperation with the Crawfordsville Community Schools, the lead school organization. In addition, the Purdue campus is located relatively near (about 30 miles) to Crawfordsville, a small rural community in central Indiana. IUPUI has a similar long-term relationship with, and proximity to, the Indianapolis Public Schools. Hence, Purdue University works primarily with the Crawfordsville Community Schools, and IUPUI works primarily with the Indianapolis Public
Schools on the professional development aspects of this project. Because of funding patterns, grant activities involving Indianapolis teachers will not formally begin until summer of 2001, but activities involving the Crawfordsville teachers began during the fall of 2000.

The professional development activities involving Purdue faculty and teachers in Crawfordsville actually pre-date the grant by several years. In 1997, the Crawfordsville Community Schools launched a project to provide all district teachers with laptop computers. To receive a laptop, teachers had to acquire computer competencies through one of several available means. One of these was completing an on-site introductory educational technology course offered through Purdue University. Since this collaboration began, over 150 teachers have elected to take an introductory and/or advanced educational technology course through Purdue to satisfy the requirement to obtain a laptop computer.

During the fall of 2000, twenty-four Crawfordsville middle and high school teachers enrolled in the advanced educational technology course (EDCI 564, Integration and Management of Computers in Education) as the first group of grant participants. These teachers had already completed the introductory level course, which concentrated primarily on basic computer applications for teacher productivity (e.g., Word, Excel, Powerpoint), or an equivalent alternative. While the first course dealt with learning fundamental computer applications, EDCI 564 focused on integrating educational technologies in the classroom.

As a kick-off activity, we wanted the teachers to see and experience first-hand a problem-based activity involving the use of technology. So, we designed a modeling activity – a short-term problem-based learning activity. Early in the semester, participating teachers along with eighteen students from grades 6-12 and six pre-service teachers from Purdue took part in a two-day problem-based learning activity involving a significant environmental problem (water quality) in the local community. The purpose of the activity was to help the teachers understand the problem-based learning process, the roles of teachers and students, and the use of technology as a supporting tool. We involved pre-service teachers because 1) they brought a high level of technology competence, 2) they could benefit from the experience themselves, and 3) this provided a vehicle for initiating collaboration between the university students and the K-12 teachers and students. We involved K-12 students because a growing body of literature suggests changes in teacher-student relationships can accompany technology integration (e.g., Ertmer & Hruskocy, 1999; Ringstaff & Yocam, 1994). We wanted teachers to work with students as co-learners in this process.

During the two-day activity, mixed teams of participants first were presented with the driving question on water quality, "What’s in our water, why is it there, and what does it mean to us?" Teams designed their own investigations within the framework provided by the overarching driving question and conducted their investigations. In most cases teams traveled to field sites to collect water samples and used available water test kits to assess what was in their samples. Finally, each team produced a multimedia report of their investigation and findings, which was then shared with the other teams on the second day. Rather than teaching about technology, the emphasis in this approach was on using technology as an authentic tool to gather background information (e.g., Internet searching), collect data and artifacts (e.g., digital camera photos of field sites, Excel graphs of data), and assemble and present multimedia reports of the investigations (e.g., Powerpoint presentations). Results of an evaluation of this activity are presented below.

Following the modeling activity, the teachers participated in a semester-long in-service development program that consisted of a specially tailored version of the EDCI 564 Purdue course. The professional development course focused on development of participants’ knowledge and skills to integrate technology within a problem-based context. Several activities involving the use of technology in a problem-solving context were employed during the course. For example, early in the course, participants engaged in a spreadsheet activity involving prediction of the medal times/distances for track events in the 2000 Summer Olympics in Sydney, which took place during the course. A Webquest activity was used to introduce concepts related to evaluation of websites. A web-based discussion board was utilized to give participants the opportunity to reflect on class topics and interact with peers. A history-based activity required teams of participants to research and develop multimedia presentations to convince their peers of the historical significance of one decade of the 20th century. These activities were designed to demonstrate additional ways that technology could be integrated into the classroom in a problem-centered context. As a culminating course activity, participating teachers developed their own problem-based learning activities, incorporating technology, to be implemented in their own classrooms during the spring of 2001. As a means of sharing their project plans, teachers also produced websites describing their projects.
Outcomes

The two-day modeling activity was viewed as a key element of the professional development approach, because in a relatively short time it allowed teachers to experience the process, understand the roles of teachers and learners in the process, and see effective ways to utilize technology. At the end of the activity, a short evaluation form was administered to all participants. This evaluation form consisted of eight Likert-type items, five semantic differential items, and five open-ended items. Table 1 presents the mean ratings by participant group for the Likert-type and semantic differential items.

Table 1. Mean Ratings of Evaluation Items from the Two-Day Problem-Based Modeling Activity

<table>
<thead>
<tr>
<th>Evaluation Item</th>
<th>Mean Rating</th>
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<tbody>
<tr>
<td><strong>Likert-type Items</strong></td>
<td></td>
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<tr>
<td>1. In this activity, I feel like I learned a lot of science.</td>
<td>4.36</td>
</tr>
<tr>
<td>2. In this activity, I feel like I learned new things about using technology.</td>
<td>4.29</td>
</tr>
<tr>
<td>3. I would rather work by myself than work in groups.</td>
<td>2.14</td>
</tr>
<tr>
<td>4. I did not like the hands-on activities.</td>
<td>1.36</td>
</tr>
<tr>
<td>5. Compared to what we usually do in school, I liked this activity better.</td>
<td>4.71</td>
</tr>
<tr>
<td>6. I do not really like school.</td>
<td>2.29</td>
</tr>
<tr>
<td>7. This project is okay, but it does not really relate to me and my life.</td>
<td>2.07</td>
</tr>
<tr>
<td>8. Because of this project, I am more confident in my ability to do investigations.</td>
<td>3.93</td>
</tr>
<tr>
<td><strong>Semantic Differential Items</strong></td>
<td></td>
</tr>
<tr>
<td>1. Boring … Exciting</td>
<td>1.79</td>
</tr>
<tr>
<td>2. Challenging … Too Easy</td>
<td>3.43</td>
</tr>
<tr>
<td>3. No Fun … Fun.</td>
<td>1.57</td>
</tr>
<tr>
<td>4. Worthwhile … Waste</td>
<td>4.43</td>
</tr>
<tr>
<td>5. Best … Worst</td>
<td>4.29</td>
</tr>
</tbody>
</table>

The Likert-type items were rated by participants strongly agree (5 pts), agree (4 pts), undecided (3 pts), disagree (2 pts), or strongly disagree (1 pt). Therefore, a mean of 3 indicates undecided, while means greater than 3 indicate agreement and means less than 3 indicate disagreement. Semantic differential items were rated by participants closest to the word on the left (5 pts), closer to the word on the left (4 pts), undecided (3 pts), closer to the word on the right (2 pts), or closest to the word on the right (1 pt). Therefore, a mean of 3 indicates undecided, while means greater than 3 indicate preference for the word on the left and means less than 3 indicate preference for the word on the right.

The data for the Likert-type items in Table 1 indicate agreement with positively worded items and disagreement with negatively worded items. The strongest reactions were disagreement with item #4 and agreement with item #5. This indicates that participants did like the hands-on activities, and they liked the problem-based activity compared to what they usually do in school. Reactions to the semantic differential items indicate that participants thought the activity was exciting, challenging, fun, worthwhile, and the best.

In response to the open-ended question, "What did you like most about the activity?" participants' most common responses were working with others and learning about technology. In response to the open-ended question, "What did you like least about the activity?" responses were scattered but lack of prior knowledge and the short time frame were the most commonly mentioned. In response to the open-ended question, "What was your favorite part of the activity?" participants cited working with others, going outside, and learning about technology. In response to the open-ended question, "List something you learned in the
activity." participants mentioned science content, information about the community, and technology. Finally, in response to the open-ended question, "List some words that describe how you feel about the activity?" the most commonly cited words in order of frequency were: fun, interesting, exciting, and worthwhile. The results suggest that participants had positive reactions toward the problem-based modeling activity while learning about science and technology.

The in-service professional development course that followed the initial modeling activity was designed to adhere to principles of good professional development practice. It was school-based; classes took place each Tuesday after school, a time that was generally convenient for participating teachers, in a computer laboratory/classroom in Crawfordsville High School. It took place over an extended period of time, a whole semester. This gave participating teachers the opportunity to practice what they learned and hence grow under the coaching and guidance from the university faculty and project staff. The emphasis in the course was on integrating technology for student learning, not on learning about technology devoid of context. The course was highly collaborative; most of the problem-centered activities throughout the semester involved teams of teachers working with one another. We hoped that this course collaboration would carry over into collaboration in the classroom when teachers implemented their own problem-based learning activities.

As a culminating activity in the course, teams of participating teachers developed their own problem-based learning units for implementation in the classroom during the spring of 2001. The components of these projects included: a driving question, curriculum objectives and links to curricular standards, possible student investigations and other activities, materials and resources, and assessment. The driving questions that were developed by the teachers to guide their projects were:

- Why should we care about deforestation of the rain forest? (interdisciplinary middle school unit)
- What makes the good life? (high school English, social studies, and elementary special education)
- What is conformity and how does conforming / not conforming affect our society? (high school English and music)
- What good is math and science? (high school mathematics and science)
- What makes something strong? (middle school technology and physical education)
- What would it take to live off planet Earth? (middle school interdisciplinary unit)

Websites describing the teachers' projects are available online at: http://research.soe.purdue.edu/challenge.

Conclusions

Problem- or project-based learning is a promising approach that involves students investigating complex problems in authentic contexts. Technology can play an important role in this process as a tool for gathering information, analyzing and representing data, and communicating results. How can teacher educators best prepare teachers to utilize this methodology in the classroom? This project utilized an approach that involved modeling problem-based learning via a realistic activity involving in-service teachers, pre-service teachers, and students. Evaluation data showed that teachers and students alike viewed this modeling activity positively. In a short period of time, this activity was able to convey the nature and components of problem-based learning to the participating teachers. Following this activity, a semester-long in-service course that was collaborative, school-based, and focused on integration introduced additional examples of problem-based learning and allowed participating teachers to build the conceptual and skills framework necessary to construct their own problem-based curricular units. This appears to be a promising approach for helping teachers to integrate problem-centered applications of technology in their own classrooms.

References


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