Paper Title: Action Research of Constructivist Approach to Integrate Technology in Support of Standards-based Science Curriculum Development in Teacher Education

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List two or three key words which best describe your paper:
1. Teacher Education
2. Technology Integration
3. Curriculum Development
Action Research of Constructivist Approach to Integrate Technology in Support of Standards-based Science Curriculum Development in Teacher Education

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Abstract

This study examines the process of employing technology to support in-service teachers in the development of science curriculum. The action research concludes with four main challenges in the integration of technology into curriculum: computer access, computer experience, technology support and institutional support. This study suggests various ways to strengthen technical support such as electronic portfolio, site visit, tutorials, and computer software. Nevertheless, access to computer remains a critical issue for in-service teachers in rural areas.

I. Introduction

As technology has become ubiquitous in K-12 environments, the successful integration of technology into curriculum and instruction remains a main challenge in teacher education. The lack of sound pedagogy and instructional support to integrate technology into instruction can account for some of the resistance among teachers to hop on the bandwagon of technology. Many teachers are novice technology users and there are not enough opportunities for professional development. This study aims to evaluate the process of providing technological support to K-12 teachers and examine factors contributing to or impeding the integration of technology into curriculum in a teacher education course at the College of Education. The constructivist approach that emphasizes learner-control and co-construction of knowledge in a real-world context is adapted to facilitate the process of providing technology integration. Action research that investigates the means to instructional improvement within the educational experience is employed for this study.

This research focuses on the process of implementing technological support to a group of science teachers with different levels of technical skills. The objectives of this study are to:

a. Determine how technology can provide support for curriculum development
b. Evaluate the constructivist approach to the integration of technology into curriculum design

II. Theoretical framework

Piaget and Vygotsky are two thinkers whose impact on constructivism is profound. Constructivist theorists who draw from Piaget put more emphasis on individual construction of knowledge as a result of interaction with the physical environment. Constructivist theorists who are influenced by Vygotsky posit that knowledge is constructed through the appropriation of culturally relevant activities. In other words, knowledge is co-constructed with peers or experts and through immersion in a social context (Bonk & Cunningham, 1998). Jonassen et al. (1995), long-time advocates of constructivism for distance education, argue:

Constructivist principles provide a set of guiding principles to help designers and teachers create learner-centered, collaborative environments that support reflective and experiential processes. Students and instructors can then build meaning, understanding, and relevant practice together and go far beyond the mere movement of information from instructors’ minds to students’ notebooks. (p. 8)

According to Jonassen et al. (1995), the four constructivist attributes for building learning systems are context, construction, collaboration, and conversation. Context refers to the “real world” scenario in which learners can carry out learning tasks as close to the real world as possible. Learning tasks should have real-world implications so that learners can connect what they learn in the classroom with the real world. Construction concerns knowledge that is built on the “active process of articulation and reflection within a context” (Jonassen, 1995, p. 8). Learners acquire knowledge better when they can link their own experience with the learning materials and make sense of them. Learners master a subject better in the process of constructing knowledge. Collaboration helps learners to develop, test, and evaluate their ideas with peers. Learners are exposed to multiple perspectives in a problem-solving case and then come to a self-selected conclusion on a particular issue. This is an important part of the learning process. Conversation is engaged in by group members for purposes such as planning, collaboration, and meaning making. It is especially important for distance learning because most communication is done through online exchanges. A successful conversation will lead to good preparations for and completion of online tasks (Jonassen et al., 1995).

These four attributes also serve as the framework for the implementation of technology in the course for this study.
III. Course description

A. Background

The course for this research is titled "Interdisciplinary Science Curriculum: Malama I Ka Aina, Sustainability (subtitle: Environmental Bioremediation: Concepts and Practices in Environmental- and Agriculture-based Science)". This course is part of the Department of Education funded project, Malama I Ka Aina, in support of K-12 science teachers to develop both standards based and culturally relevant science curriculum to Hawaii students as described in the Malama web site (http://www.hawaii.edu/malama). Science teachers registered in this course were expected to achieve the main course objective: incorporating traditional Hawaiian cultural practices and methods of modern environmental technologies into science curriculum and instruction through an immersion program in the field and hands-on practice with community experts. This course began in summer 2001 and was concluded in May 2002.

Twenty two in-service teachers from three different Hawaiian islands registered in the course and eight site teachers provided instructional and content support for all teachers at different campuses. The course was co-taught by two faculty members from the College of Education and College of Tropical Agriculture and Human Resources. The core instructional team consisted of the instructors, a content and curriculum design specialist, and an instructional designer. The instruction was supplemented by guest instructors from Hawaiian community groups. The subject areas that the participating teachers teach included biology, agriculture, chemistry, hydroponic, physics, earth science, life science, marine science, environmental science, and general science. Since the teachers were from different islands and carry their full-load of teaching during regular semesters, meetings were usually scheduled during the weekends or semester breaks in summer. The use of technology played an important role for continuous communication in the year-round course.

B. Standards-based Curriculum Development

One important aspect of the course is the incorporation of science standards into unit and lesson plans. A standards-based curriculum provides a set of guidelines for teachers to develop the content and devise activities that are appropriate for the various levels of the students. The standards employed in this course are based on the booklet "Hawaii Content and Performance Standards, HCPS II" developed by the Department of Education at the State of Hawaii. HCPS, which provide specific benchmarks and learning outcomes in K-12 systems, can be divided into two domains:

"(1) Domain I standards are about science as a way of thinking and knowing. It has roots in Scientific Inquiry and meets the first goal of Science Education (which is understand and apply the process, ways of thinking and dispositions that humans have while investigating the Natural World). (2) Domain II standards are about Science as Cumulative Knowledge. Domain II identifies essential understandings that will help students meet the second goal of Science Education (which is to understand and apply the knowledge we know today about the world around us to our curiosities and in our daily lives)" (p. 2-3, Office of Accountability and School Instructional Support/School Renewal Group, 1998).

Examples on unit and lesson plans that address the benchmarks in the standards can be found at the Malama web site.

C. Technology

The four constructivist attributes, namely, context, construction, collaboration, and conversation provide the foundation for the design of the technological learning environment. The context was the subject area in which the teachers developed the instruction and activities for their own classroom use. This course provided the training opportunities for the teachers to acquire the skills, knowledge and technology for curriculum development. They were to construct the curriculum through either group projects or individual projects based on their own disciplines and background knowledge in a subject area. Through collaboration with other teachers in the same group, they drew on experiences from their own teaching in different grade levels and contributed their knowledge to the project. For teachers in different groups, they engaged in online conversations to comment and receive suggestions from peers on their own projects. Throughout the entire year, online conversation was encouraged to increase the understanding of the course content and information sharing.

The role of technology in the Malama program was to foster a learning environment in which participants collaborated together to develop a database of K-12 standards-based science curriculum for information dissemination. The participants did not meet on a regular basis. The email list and the web tools played a vital role in
the communication between instructors and participants. The Malama web site provided the resources and venue for teachers to disseminate information, collaborate on projects, carrying out discussion and co-construct knowledge together.

Specifically, the tools employed in the course included: email, web pages, bulletin board, chat room, and listserv. In order to make sure that every teacher learned how to use the web editor Dreamweaver and publish their curriculum on the web, a two-day technology workshop was planned and conducted by the Malama instructional support group in a computer lab. The workshop description can be found at http://www.hawaii.edu/malama/handouts/DW_workshop.html (there is an underscore between DW and workshop.html). Participants were provided with detailed handouts and online resources for learning about Dreamweaver. Preview of the lesson plan and preparations for the workshop were sent to the teachers in advance. One of the objectives of the workshop was provide teachers with the skills and knowledge necessary to maintain their own web sites. Eventually, they would also be able to integrate the technology into the lesson plans and teach their students the technical skills necessary to develop their own projects.

IV. Research design and data collection

A. Action research for instructional and technical improvements

Action research is a process that involves all participants (e.g. students, teachers, and other parties) in the educational process to work together for the improvement of instruction and curriculum. Social psychologist Kurt Lewin's work (1946) has contributed greatly to the maturation of Action Research as a method for research. According to Lewin's (1946) definition, "action research is a three-step spiral process of (1) planning which involves reconnaissance; (2) taking action; and (3) fact-finding about the results of the action" (p. 27, cited by Kemmis, 1988). Action research is ideal for generating insightful information for the improvement of school programs. It provides educators the opportunities to evaluate new ideas about teaching, curriculum, and learning so that they can make informative decisions.

The design of action research is described by Kimmis & McTaggart (1988) in the following cycle: plan -> act -> observe -> reflect -> and revise plan -> next cycle in similar sequence. This study is conducted in the following sequence: selecting research areas/focus, taking action, collecting data, organizing and interpreting data, reflecting on action, and revising action plan.

This research focuses on how technology can support teachers in developing curriculum. Two research areas are identified: factors that enhance or impede the support of technology and assessment of the constructivist approach to the implementation of technology. The research is concerned with how technology can provide support for teachers and how teachers can benefit from the constructivist approach. The action plans include needs assessment, technology workshops, and follow-up support. The following data are collected to assess the process and effectiveness of the technological support: surveys, interviews, observation, and project evaluation.

a. Research areas

This study focuses on how technology can support teachers in developing curriculum. Two research areas are identified: (1) factors that enhance or impede the support of technology, and (2) assessment of the constructivist approach to the implementation of technology

For the first area, the following research questions investigate how technology can provide support for curriculum development:
1. Does the use of technology facilitate curriculum development?
2. Does technology provide the kind of support for teachers to develop curriculum?
3. What kind of support can be further provided?
4. How do novice teachers adopt to technology? What are the factors that enhance or impede their adoption of technology?

For the second area, the following questions evaluate the constructivist approach of integrating technology into curriculum design:
1. Context learning: the effectiveness of using real-world context as the backdrop to develop lesson plans
2. Knowledge construction: the effectiveness of knowledge construction through web resources and information sharing
3. Collaboration: the effectiveness of team collaboration
4. Conversation: the effectiveness of peer critiquing and information sharing through the web bulletin board
b. Action Plans

Several actions are taken to provide support of technology to teachers.

1. Needs assessment: a preliminary survey is conducted to assess the technology literacy of each teacher and the type of technical support from their respective schools.
2. Tech workshops: several technical workshops are conducted for individuals and the whole class to advance teachers' knowledge in technology, specifically web page editing tools.
3. Follow-up support: Once the teachers' web sites are uploaded to the Internet, the instructional support team can monitor their progress and keep close watch on problems that the individual teachers may encounter.

B. Data Collection

The following data are collected to assess the process and effectiveness of the technological support:

a. Preliminary survey on demographic background, technical skill levels, and the institutional support available.

b. Post-workshop survey to evaluate the following aspects of the technology workshop: workshop structure, instructor-participants interaction, overall workshop enjoyment/satisfaction, and computer lab learning environment. (http://www.hawaii.edu/malama/surveys/workshop_eval.html). The questionnaire is adapted from the study by Thomerson and Smith (1996).

c. Observations by instructors: the instruction team reports their observation on teacher's adoption of technology (http://www.hawaii.edu/malama/surveys/project_observation.html)

d. Evaluation of final projects (e.g. web site completion, indication of employing technology in classroom activities and student projects)

The data analysis, critical reflection, and revised plan are discussed in the next section.

V. Analysis and discussion

A. Preliminary study

There were eleven male and eleven female in-service teachers participating in this course. The preliminary survey revealed four technological challenges in this course: computer access, computer experience, institutional support, and technical support. As concerns computer access, three teachers did not own a computer at home and they did not use a computer at school for instructional purposes. These teachers did not have email accounts at the beginning of the course. This mixture of novice and advanced computer users presented the first technical challenge of this course: keeping the communication flow in a class that did not meet regularly physically or virtually. The instructors usually sent out class-related announcement via email and then notified other teachers who did not have email accounts by phone calls or mail. After the first technology workshop was held in late July, all teachers except for one had e-mail accounts. Nevertheless, the lack of computer access for some teachers in rural areas made it impossible for them to receive email promptly and efficiently.

Regarding computer experience, only two out of twenty-two in-service teachers had their own web pages. The majority had little or no experience in creating web pages. The July technology workshop aimed at advancing their web editing skills to at least beginner level so that they could start planning curriculum with the aid of technology.

In terms of institutional and technical support, although most K-12 schools are already equipped with computers, schools in rural areas are still ill equipped. There is also a lack of institutional support in providing technical support for teachers. One of the Malama project objectives is to empower the teachers with the knowledge to develop web pages. This initiative was contingent upon the technical support and Internet access from each site school. Half of the teachers were not aware of the kind of technical support that their individual schools would have provided.

B. Technology workshop surveys

The overall ratings of the workshop evaluated by the participants are high. On a one-to-five scale, one as low and five as high, the workshop ratings as indicated in the parentheses include the following categories: Instructor-participants interaction (4.1), computer lab learning environment (3.1), workshop structure (4.07), and overall enjoyment and satisfaction (4.36) as shown in Table 1. The comments by the participants offered excellent suggestions in the following areas: smaller class size, classes for participants with different levels of computer skills, multiple sessions, longer workshop hours, and more detailed instructional manuals. Twenty-three teachers who shared 19 computers attended the two-day workshop (three hours each day).
Table 1: Post-workshop Survey Results

<table>
<thead>
<tr>
<th>Instructor-participants interaction</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 I felt comfortable asking the instructor questions.</td>
<td>4.57</td>
</tr>
<tr>
<td>Q4 I felt uncomfortable asking for help during workshop</td>
<td>2.36</td>
</tr>
<tr>
<td>Q5 The instructor was responsive to students' needs.</td>
<td>4.36</td>
</tr>
<tr>
<td>Q11 When I ask questions, the instructors give me the answers I need.</td>
<td>4.64</td>
</tr>
<tr>
<td>Average</td>
<td>4.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning environment (computer lab)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2 The overall workshop design was conducive to learning about writing web pages.</td>
<td>4.0</td>
</tr>
<tr>
<td>Q7 The screen layout and interface design of portfolio are consistent and easy to use.</td>
<td>4.14</td>
</tr>
<tr>
<td>Q13 I had a difficult time understanding the instruction.</td>
<td>2.86</td>
</tr>
<tr>
<td>Q16 I tend to get easily distracted in a computer training environment.</td>
<td>2.79</td>
</tr>
<tr>
<td>Average</td>
<td>3.1</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Workshop structure</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 The instructor used the computer effectively for meeting the objective of the workshop.</td>
<td>4.43</td>
</tr>
<tr>
<td>Q6 Examples and illustrations were effectively used by the instructor.</td>
<td>4.21</td>
</tr>
<tr>
<td>Q8 The amount of material covered was adequate for the length of the workshop.</td>
<td>3.71</td>
</tr>
<tr>
<td>Q10 Workshop content was presented in a well-organized manner.</td>
<td>3.93</td>
</tr>
<tr>
<td>Average</td>
<td>4.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overall workshop enjoyment/satisfaction</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q9 I have a sense of accomplishment so far.</td>
<td>4.07</td>
</tr>
<tr>
<td>Q12 The method of workshop presentation kept my interest high through the entire workshop.</td>
<td>4.07</td>
</tr>
<tr>
<td>Q14 I would recommend that other teachers take similar courses from the same instructor.</td>
<td>4.36</td>
</tr>
<tr>
<td>Q15 The instructional team was helpful in providing assistance.</td>
<td>4.93</td>
</tr>
<tr>
<td>Average</td>
<td>4.36</td>
</tr>
</tbody>
</table>

*Q4, Q13, & Q16 have been reversed for tabulation.

C. Follow-up support
Based on the preliminary surveys, the following action plans were taken to provide continuing support:

a. Schedule a series of workshops on computer literacy, web page design, image scanning and processing, and power point presentation
b. Provide individual on-site tutoring for teachers who need extra help
c. Communicate with school tech coordinators on the kind of support and resources that the teachers would need in developing their own web sites
d. Site visit with teachers who have the least computer experience to assess the kind of support that was needed for them to utilize the technology for project development at their own schools
e. Provide books and computer software site licenses for all teachers to develop individual projects.
f. Develop electronic portfolio that provides standard-based curriculum template for teachers to download
g. Establish a web-based bulletin board on WebCrossing for information dissemination.

D. Observations
Two instructors and one curriculum specialist who were also present to observe the workshop and learned about the technology made comments on the following four categories: overall participant satisfaction, course structure, course design, and instructor-participant interaction. The observations are summarized as below:

a. Overall satisfaction: While three observers agreed that the members of the workshop seem to be happy with the fact that they have learned something new, the learners also seemed overwhelmed by the amount of materials rendered in the workshop. Because there was a large variation in the skills initially, each participant moved to a different level, but all make progress in their best capacity. One observer pointed out that those who had minimal exposure to computers would have benefited more from one-to-one tutorial session than a large workshop.
b. Workshop structure: The course was well-organized and the examples used are relevant to teachers’
background. While learning about the technology, they also learned to build an electronic portfolio through
several templates. The templates consisted of a consistent layout and several web pages that include school
introduction, project overview, standards-based unit planning, unit and lesson plans, student works, and
photo gallery. Participants can download the electronic portfolio templates and provide content to the
templates without investing much time on web design. Through the use of a template, participants were at a
place that they could see good quality results and get excited. Nevertheless, observers suggested that
handouts with step-by-step instruction (where to go or click from point A to point B) would be more useful.
The handout was written for participants in a face-to-face workshop for reviewing purpose, not for self-
guided tutorials. In addition, it would be even better if the participants could upload their web pages to the
server and see the results. Since the workshop was conducted at the beginning of the course, many
participants have yet to received an email account from the University. Web server access was tied to the
availability of an active email account. Therefore, many of them could not upload their practice files to the
server even though the instructions were included in the handout.

c. Workshop design: The strengths of the workshop were the use of the handouts, computer projection, and a
portfolio that the participants can download as a template for their own projects. The weaknesses were the
large size of class (19 participants), fast-paced instruction, and a lack of sufficient time for practice. For
future workshops, an introductory course for beginners and an intermediate course for participants with
basic skills would make it easier to conduct the instruction.

d. Instructor-participant interaction: While the observers all agreed that the instructor was helpful and
responsive to questions, the use of tech assistants also contributed greatly to the positive interaction. It was
helpful for both the instructor and the assistants traveled frequently to different corners of the room to
provide timely assistant to the participants.

e. Additional comments: Instead of compressing the instructional materials into two afternoons, the
workshop could have easily stretched into a three-day workshop to allow more time for practice. The
participants definitely need follow-up support and practice on their own to retain all the materials covered
in the workshop.

E. Final project evaluation

Fourteen (64%) out of a total of twenty-two teachers posted their projects on the web. Teachers from the
same school usually collaborated on the same project together. Half of the projects posted on the web showed a
good command of basic web authoring skills. Two projects showed advanced level of web authoring mainly because
the two teachers had prior web authoring experience before registering for the course. Two projects showed
intermediate level of web authoring skills and the teachers had minimal experience with web authoring. The reasons
that the web editor (Macromedia Dreamweaver) was not highly utilized by participants to develop their projects can
be summarized as follows: (a) putting projects on the web was not a requirement for this course, teachers also have
the option to submit their paper in a format other than web pages; (b) a steep learning curve of the web editor might
have discouraged beginners from continuing using the program; (c) busy work schedules kept the participants from
spending time in learning more about or effectively using the web authoring program which was an add-on task to
project development; (d) a lack of access to good computers might have deterred teachers who had no experience
with computers and living in rural areas.

In addition, most projects developed by the participants did not involve students in the use of computer
technology in their learning. In spite of the minimal use of web technology in developing curriculum by most of the
participants, their projects did employ modern environmental technology and address the science-standards
developed by DOE at the State of Hawaii. All the projects showed real-world applications and participants reported
successful results with their students. All lesson plans can be viewed at the Malama Web site:

F. Analysis on technology use

Overall, email and the Malama Web site were the main means of communication. In the Malama listserv,
the majority of postings were submitted by the instructors, tech support, and the same two or three participants. The
majority were passive users of the communication technology. Technology integration was most successful for
projects by teachers who had already had some knowledge in using the web. With all the technological support and
effort to make technology available for teachers, most teachers would only use technology for communication
purpose, not for project development. The use of technology was a recommendation, not a requirement, in the
course syllabus and thus partially explains the lack of incentives by some participants in the incorporation of technology into curriculum.

The constructivist approach to encourage context learning, knowledge construction, collaboration, and conversation would have worked well with in-service teachers whose skill levels are more or less at the same level in well-equipped K-12 teaching environments. For the course in this study, the participants were geographically dispersed throughout the Hawaiian islands with different skill levels and unequal access to computers, it would take more than one technical staff to provide the kinds of support that the teachers would have needed. Furthermore, more structured tasks in motivating teachers to use technology should be an integral part of the course design, not an add-on task.

VI. Conclusion

In the process of employing technology to support curriculum development, the following four challenges in most rural schools need to be addressed first: lack of computer access, computer experience, institutional support, and technical support. There is a need to provide more access to computers and technology support for in-service teachers before any technology projects can be implemented. This study presents a typical scenario in teacher education and ways to provide the best support with limited resources. It is not a surprise to find out that those teachers who are successful in utilizing technology are those who have access to the resources in this study. Providing computer access to all K-12 teachers and continuing professional development should provide the foundation toward a successful integration of technology into curriculum.

VII. Bibliography


