Development of an e-Learning Course on ICT Integration for Secondary School Science Teachers

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ABSTRACT

This study developed a course on technology integration in Science teaching for secondary schools. A survey conducted to eleven Integrated Science I teachers in Iligan City to determine the appropriate content and delivery for the developed course revealed that there are five teaching approaches necessary for technology integration - namely interdisciplinary approach, tools approach to technology integration, cooperative learning, problem-based instruction and authentic assessment strategies.

The course allows teacher participants to work in stages for their teaching portfolio. It has the following stages: introduction of problem-based learning, setting the context by knowing the learners and identifying learning standards, developing a problem situation and mapping interdisciplinary units for the identified topic, formulation of learning objectives and evidence of attainment, organizing the learning environment and preparing assessment tools.

Results of the instructional design evaluation using the instrument of Moore and Kearsely (1996) shows that the content experts strongly agree that the online course followed the general design principles for web-based course instruction except for the criteria on "completeness" and "repetition". Most of the expert evaluators observed, using the heuristic usability evaluation tool of Karaoulis and Pambortsis (2003), that the course meets the criteria on: quantity, quality and value of content; Online Distance Learning Adaptation and integration; user interface; use of the underlying technologies; interactivity with the instructional material; provision for student support and communication channel; acquisition of knowledge; projects and learning by doing; and assessment according to the principles of ODL. Suggestions were to improve the course's functionality and technology use; and increase the number of tutorial sessions, exercises, and hands-on practices.

The course is packaged to include resource kits -course guide, resource manual, and an interactive CD that directs them to activities in the online classroom via the MSU-Iligan Institute of Technology Online Learning Environment (MOLE).

It is recommended that the course be evaluated for effectiveness through the conduct of pilot implementation.

INTRODUCTION

Technology integration in the classroom now has become a necessity that professional development programs must be geared towards this end. Currently the Department of Education

with partner institutions has been conducting professional development programs in this area. These programs require teachers to learn new roles and ways of teaching that translate into a long-term developmental process that would involve focus on changing their own practice. But teachers have busy schedules and finding time for change poses a problem. (McDiarmid, 1995).

A more flexible system of professional development through e-learning might address this problem. Such program would reach teachers regardless of where they live or work; it is available anytime and anywhere and it reduces travel time and expenses. It can provide large number of teachers with quality professional development which can be embedded into the daily lives of teachers. It is in other words, a cost effective means of addressing professional development problems (Multi-State Professional Development Program, 2006; Tinio, UNDP E-Primer; Asian Development Bank-Distance Education for Primary School Teachers, 1997).

This study aimed to develop an online professional development course on technology integration for Science secondary teachers in Iligan City.

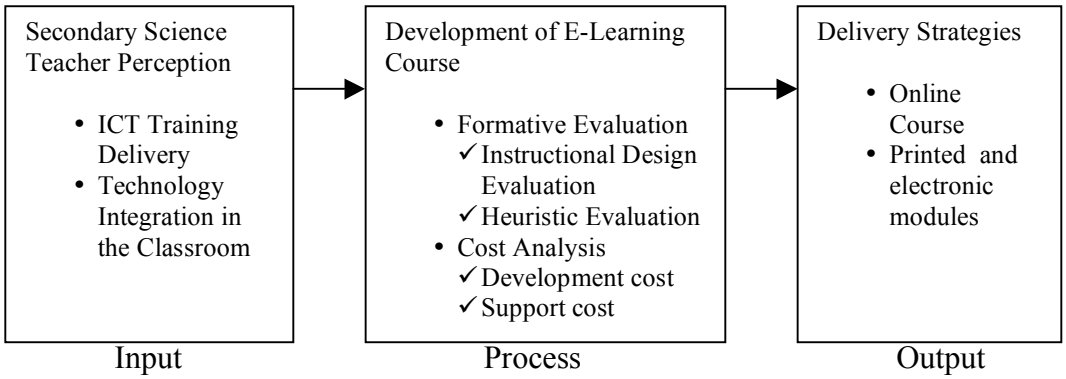


Figure 1. Diagram of the Conceptual Framework

In this study the perceptions of secondary Science teachers on ICT training delivery and technology integration formed as bases for the content and delivery of the training course. In the development of the course formative evaluation is done by experts prior to and after the course is uploaded in a virtual classroom. The usability of the course is evaluated by experts using usability heuristics. Cost analysis is necessary to determine the feasibility of the course and must be on-going as the course is developed.

Delivery strategies were identified through the creation of Instructional Design Model for Developing SciTeach e-Learning Course and Instructional Design Model for Integrating Technology in Science Teaching. A packaged E-learning course that includes the uploaded course via the MSU-IIT Online Learning Environment (MOLE), the printed learning resource manual and learning partner CD-ROM are the outputs of this study. The course code for the course is **SciTeach.** .

METHOD

Research Sample and Setting

There were three research samples utilized in this study. The first group was utilized during the conduct of analysis of intended participants and need of the training course. There were eleven respondents for this group and they were identified through purposive sampling. They were public secondary school teachers who were identified by their respective principals.

The other sample was identified also through the purposive sampling method during the expert usability evaluation of the developed course. There were six (6) content experts who evaluated the instructional design of the course. They were chosen on the basis of their expertise in Science Education and Technology Integration areas. This means that they were graduates of Science Education, were teachers of Science Teaching strategies and had undergone training in Technology Integration.

The third sample was six (6) ICT experts who evaluated the usability of the SciTeach course. They were chosen based on the criteria of Karaoulis and Pambortsis (2003) as Human-Computer Interaction Experts (HCI) where only 3 to 5 of such evaluators can identify 75% of heuristically identifiable problems. They are experts in Information and Communications Technology (ICTs) and are well versed in Distance Education Pedagogies and have been using the MOLE.

The evaluation of the course by experts was done in an online setting. They logged on to the *SciTeach* classroom to complete the evaluation.

Development of SciTeach E-Learning Course

The study has four phases, namely the analysis phase, the design and development phase, heuristic usability evaluation phase and the cost analysis phase. The following briefly describes each phase of this study and is illustrated in figure 2.

Analysis Phase

In the analysis phase, needs and constraints were defined. Analysis was conducted as suggested by established e-learning course design models such as the ADDIE model, the Tripp and Bichelmeyers' Rapid Protoyping model, and the Dick and Carey model. This phase was necessary because the end purpose of designing and developing a course is to determine usability. Shilwant and Haggarty (2005) mentioned that another means of building usability into the design is by utilizing the information gathered during the intended participants' analysis, and needs assessment.

Teachers filled out a questionnaire and then interview was conducted to gather more information. The information gathered formed as bases for the content and delivery of the training course. This also allowed for the building of personas. Personas can provide guidance needed to stay focus on the end user and make informed decisions about the functionality and design of the course when the actual end users are not available for testing.

Design Phase

Using all the inputs considered in Phase 1, the researcher designed a curriculum for the course. The knowledge gained during the analysis phase together with the personas derived was utilized in the construction of the content and strategies in delivering the SciTeach course.

Instructional design analysis was first conducted in the design phase. This involved summarizing information gathered from the analysis of intended participants, drafting instructional design suitable for Technology integration as the content for the course, and drafting an instructional design for online delivery.

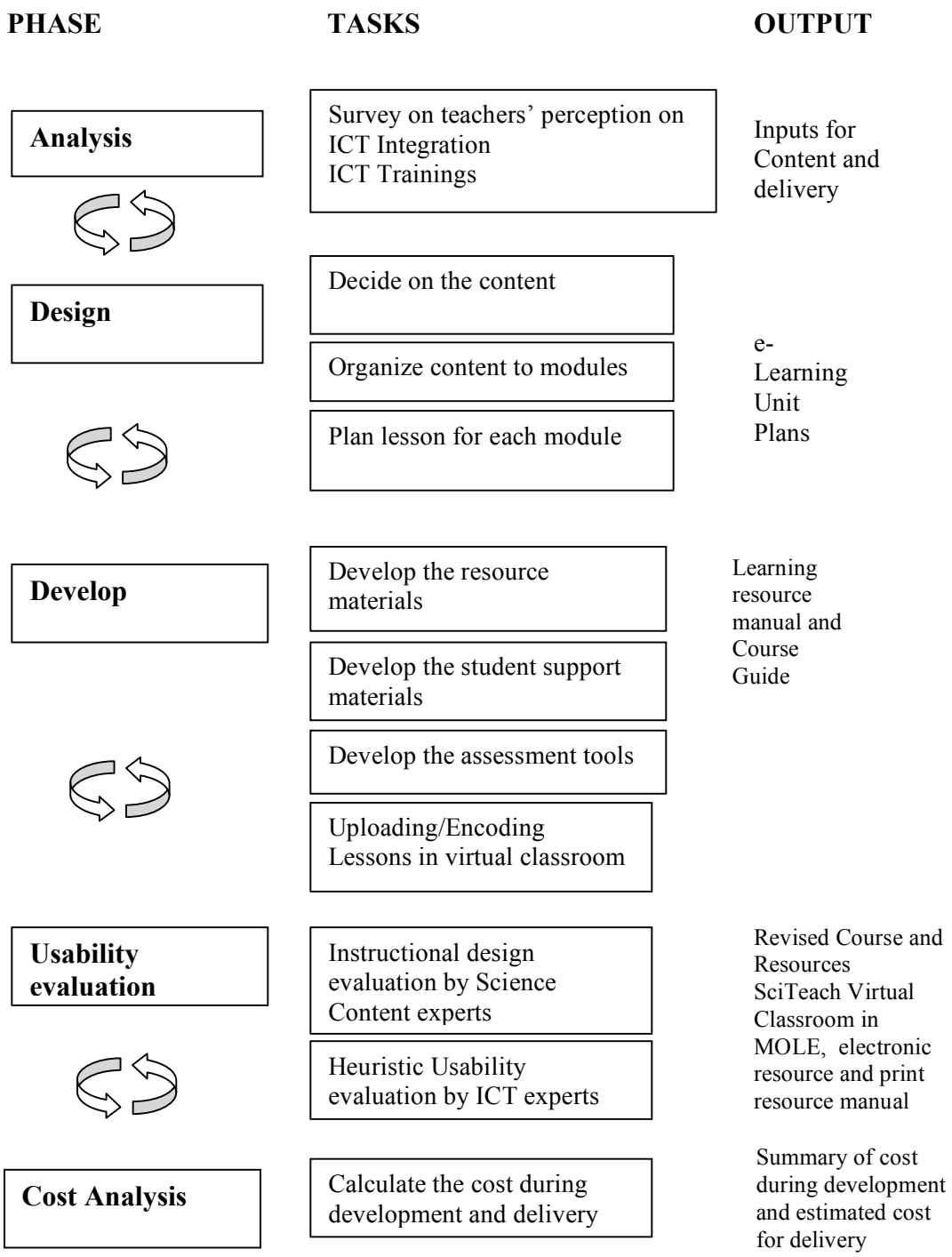


Figure 2. Development of SciTeach e-Learning Course Model

The problem-based instruction design, the tools approach to integrating technology and the principles of Integrating Technology for Inquiry (NTEQ Model) of the Appalachian technology in Education consortium were considered in as the major inputs utilized for the content. The e-learning methodology of Chief Learning Officer website, the achieving usability design model of Shilwant and Haggarty (2005) and ADDIE model, plus the perceptions of intended participants on online delivery of teacher trainings, were utilized as inputs for the instructional design delivery of the SciTEach course.

The content for the course was then organized into modules, followed by the formulation of course goals and unit objectives. The objectives were evaluated by the adviser and co-adviser, an expert in technology integration. They were later revised and checked by the same experts. Once the goals and objectives were set, the first version of the e-learning course planner was developed and then revised. This revised version became the basis for the development of course modules.

Development Phase

With the planner as the guide, the organization of the content and activities per module followed. The fist and second version of learning modules was subjected to instructional design evaluation by content experts. Doing this follows the E-learning engineering principle (Moore and Kearsely, 1996), which states that prior to uploading of the course and providing access in the virtual classroom, the course design and content must be evaluated. Shilwant and Haggarty (2005) termed this as *Instructional Audit,* which is testing the instructional design and learning activities of the course prior to the development of the e-learning course in order to eliminate the need for costly and time-consuming adjustments.

After the incorporation of suggestions from the content experts, a newer version was developed to include resource materials, student support materials and assessment tools. These were organized and compiled into one course guide and learning resource in print for the SciTeach Course.

Simultaneous to the development of learning resources in print was the uploading and encoding of lessons, activities and assessments in the MSU-IIT Online Learning Environment. Heuristic usability evaluation of the SciTeach course was then conducted and results led to the development of another version of learning resource material in print and the virtual classroom with the addition of creating a CD-ROM learning partner of the SciTeach course.

Expert Heuristic Usability Evaluation Phase

After the virtual classroom for the SciTeach course was established, the researcher identified the evaluators. The first set of evaluation was then conducted using the instrument for Instructional Design Evaluation by Moore and Kearsely (1996) and Usability Evaluation by Karoulis and Pambortsis (2003). Results from this initial evaluation were used to improve the structure of the course materials, add more opportunities for student interaction, supply more examples; improve packaging of the learning resource guide, add summaries and closing statements.

These results of the initial evaluation by experts led to the revision of the uploaded SciTeach course in MOLE and the printed Learning Resource Guide. The new learning resource

had the following parts: reflection of the teaching practice, reading portion, the activities and assignments, self-assessment and additional or required reading and the conclusion. The revised SciTeach course and learning resource material was then subjected to evaluation by the same two groups of experts- Science content experts and ICT experts.

Cost-analysis Phase

In the cost analysis, costs for the development and delivery of the course were computed. Only tangible costs were included. The development costs included the salary of the developer and the supplies and materials spent during the analysis, design, development, and evaluation of the course. Cost for the delivery included the cost of operations of the Computer center using data from the MSU-IIT Budget office and the personal cost for faculty assigned to implement the course.

Data Sources

Analysis Phase Instruments

The instrument used for data gathering in the analysis phase was a questionnaire. The first part of the questionnaire elicited data on the perceptions of teachers on technology integration, technology integration training delivery, and the conduct of these trainings in a virtual classroom.

Since the SciTeach course aimed to develop understanding of technology integration among target participants who were the Secondary School Teachers, it considered two underlying concepts. These are the concepts of technology integration and the concept of science teaching. During the conduct of literature review, the researcher merged ideas of Sherman and Sherman (2004) on what constitutes Science teaching and of Grabe and Grabe (2004) on the components of technology integration. Hence, in the questionnaire, the respondents were asked to check the items below that they observed during their ICT integration in the classroom.

- Technology Integrated into Science Content Instruction
- Tools Approach (Applying technology to a learning task)
- An Active Role for Students (Students' constructive mental behavior)
- Facilitative Role for the Teacher (Teachers assist students with challenging projects)
- An Integrated or Multidisciplinary Approach (Using a wide range of skills and variety of areas)
- Cooperative Learning
- Science and Values
- Scientific Method
- Alternative Assessment Techniques

An interview was conducted to reinforce their answers. The questions asked were: What is technology integration?; Is it beneficial for teachers to undergo professional development training on technology integration; is it beneficial for teachers to participate in these trainings in

an online mode. They were also asked to give comments or opinions on professional development trainings in an online learning mode.

Usability Evaluation Instrument

The instruments utilized in the usability evaluation of the course were adapted from the *Heuristic List* of Karaoulis and Pambortsis (2003) and *Course Design General Principle List* of Moore and Kearsely (1996).

The instrument of Moore and Kearsely (1996) were used to evaluate the instructional design of the course. The construction of the questionnaire followed 10 principles namely- good structure, clear objectives, small unit, planned participation, completeness, repetition, synthesis, simulation, variety, open-ended, feedback and continual evaluation. Evaluators were then asked to rate the course. They were to encircle 1-strongly disagree, 2-disagree, 3-agree, and 4-strongly agree.

The heuristic list adapted from Karoulis and Pambortsis (2003) for this study has the following axes: Content, ODL adaptation and integration, User interface, Use of technologies, Interactivity with the instructional media, students' support, communication channel, Acquisition of knowledge, Projects and "learning by doing", and the Assessment and self-assessment. From these 10 axes, there were two questions answerable by yes or no for each axis. Evaluators then noted their opinions for each of these questions.

RESULTS AND DISCUSSION

The survey of the science teachers showed that ICT Integration in Science Teaching involves the use of technologies as tools to explore the content of the subject to make it more appealing to students; the use of technologies in learning a task and developing a skill; consideration for non cognitive skills such as communication skills-reading, writing, speaking, artistic expression and library research skills; teachers being facilitators of learning; students being mentally active, producing projects, observing Scientific method, and are working in groups; and authentic assessment of students learning. This implies that the expected content for an ICT integration training programs on Science teaching are all covered in the SciTeach course.

Science Secondary school teachers perceived that professional development programs on ICT integration and other professional development trainings delivered online beneficial. It can be said then that offering SciTeach course to Science secondary teachers is feasible.

However the major concern of teachers was the problems of cost and dependence on computers and the internet. This indicates that cost benefit analysis is necessary prior to offering of online programs. As regards to dependence on computers and internet, course participants should be provided enough support materials in printed and or electronic form.

The above findings were used as input in designing the SciTeach training course that aims to develop understanding of technology integration among secondary school teachers. The course will enable participants to propose students' activities centered on a problem situation, plan for

activities that are multi and interdisciplinary, design a learning environment where students use technology as a tool for learning and work in groups to achieve goals, and lastly, create thematic unit plans where students are engaged in inquiry.

The course is designed to merge the components of technology integration and Science teaching principles. As such instruction and content are guided by five (5) teaching approaches and strategies - interdisciplinary approach, tools approach to technology integration, cooperative learning, problem-based instruction and alternative or authentic assessment strategies.

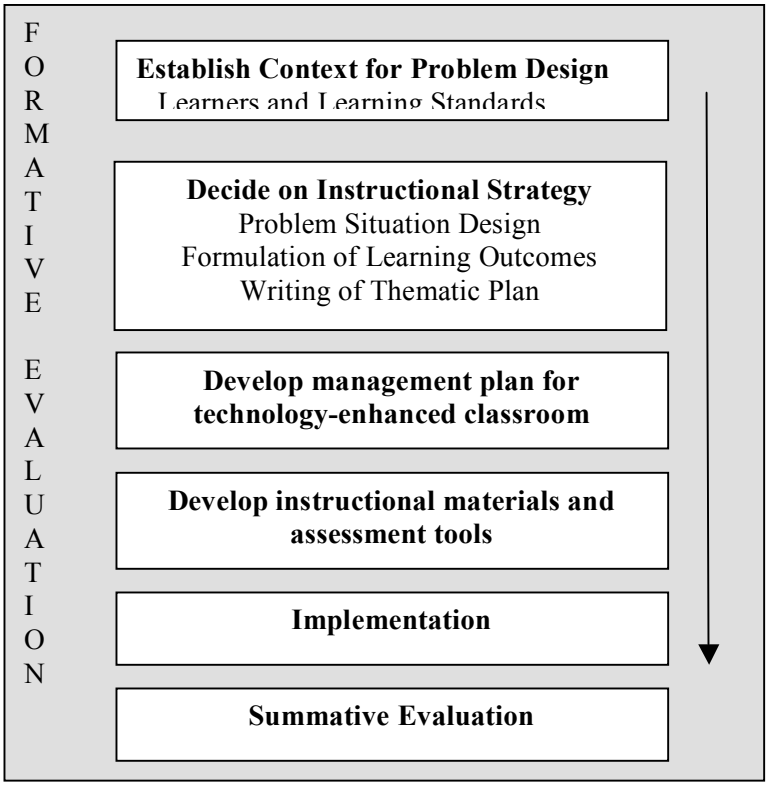


Figure 3. Instructional Design Model for Integrating Technology in Science Teaching

The course starts with an overview of technology integration where the tools approach to technology integration is discussed (see figure 3 and figure 4). This is followed by the introduction of problem-based learning. When participants are ready, they are then directed to create a thematic unit plan. To help them do this, the succeeding lessons allow them to work on their thematic unit plan in stages. First, they have to set the context for problem design which includes knowing the learners and identifying learning standards. Second, they have to develop a problem situation and map interdisciplinary units for the identified topic. This will ensure that

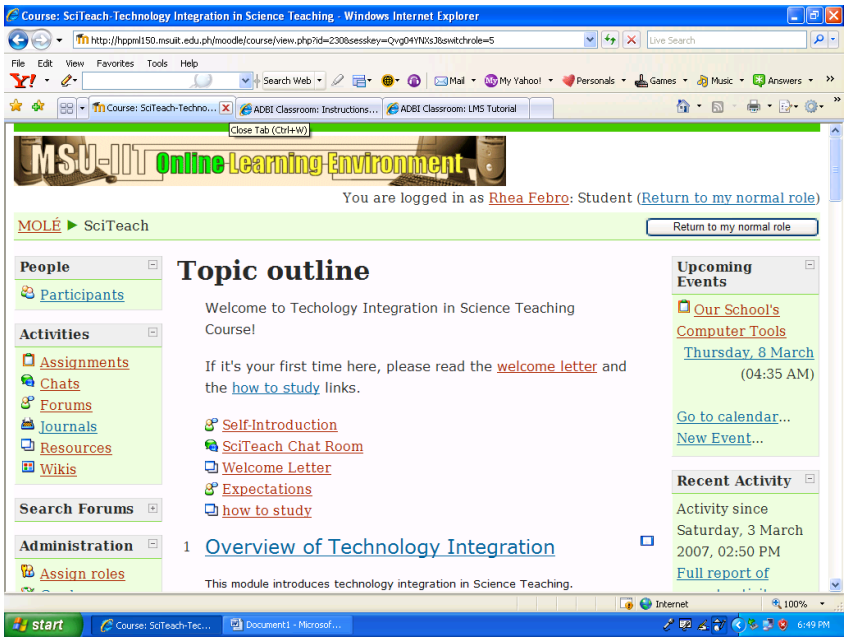
the plan they are to prepare follows the problem based learning principles. After the problem situation is clear, teacher participants will proceed to formulating learning objectives and evidences of attainment. The next step is to organize the learning environment and lastly, to prepare authentic assessment tools suitable to their thematic unit plan.

Course Outline

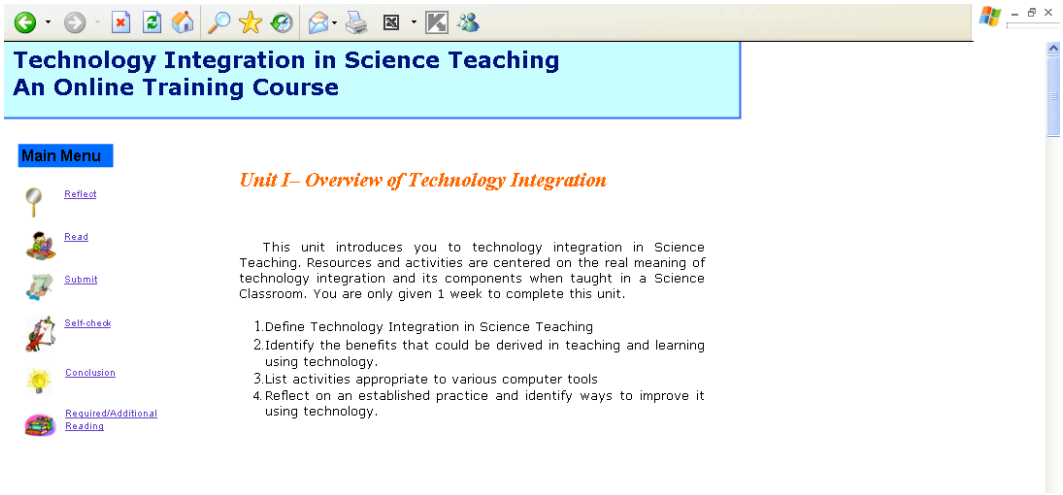
I. Overview of Technology Integration
    Tools Approach to Technology Integration
II. The Problem-Based Learning
    Theoretical Foundations
    Features of PBI
    Teaching Strategies Belonging to PBI
        Project-Based Learning
        Problem Solving
        Inquiry-Based Learning
        Anchored Instruction
        Webquests
III. The Context for Problem Design
    Characteristics of Learners
    Learning Outcomes: Learning Standards
IV. Developing the Problem Situation and Mapping Interdisciplinary Units
V. Learning Objectives and Evidences of Attainment
VI. Organizing the Learning Environment
    Organizing Students for Study
    Organizing Resources
    Scheduling Computer Time for Class
    Planning Logistics
VII. Assessment of Learning

Figure 4. SciTeach Course Outline

In order for participants to do these required tasks they are provided with learning resource kit that includes a course guide, a learning resource manual, and an interactive CD. The learning resource kit only directs them to the activities in the SciTeach classroom via the MOLE. They are required to access the course for a minimum of four hours a week. Activities include forum, wiki, quiz, assignment, journal and survey. All these activities are designed for participants to achieve the objectives of the SciTeach course.



Screenshot of the SciTeach classroom



Screen shot of Unit I in Electronic CD-ROM Partner

Based on expert evaluation (table 1), the SciTeach course is found to have a good instructional design. It follows the design principles specified by Moore and Kearsely (1996). The experts strongly agree that course has a good structure, clear objectives; the content and course organization are presented in small units, there is planned participation among students; it is properly synthesized; there is enough simulation and variety; there is evidence of being open-ended; there is regular feedback and presence of continual evaluation. There is need to improve on

the course's completeness which is done through providing extensive commentary and examples and on its reinforcement of important ideas.

Table 1. Instructional Design Evaluation by Experts

Design Principle	Mean Rating	Description
Good Structure	4	Strongly agree
Clear Objectives	3.8	Strongly agree
Small Unit	4	Strongly agree
Planned Participation	3.8	Strongly agree
Completeness	3.2	Agree
Repetition	3.2	Agree
Synthesis	4	Strongly agree
Stimulation	3.4	Strongly agree
Variety	3.6	Strongly agree
Open-Ended	3.6	Strongly agree
Feedback	3.8	Strongly agree
Continual Evaluation	3.8	Strongly agree

The SciTeach course is also usable. Most of the expert evaluators observed that the course provides acceptable quantity, quality and value of content; it is capable of Online Distance learning Adaptation and integration; it has good user interface; it makes full use of the underlying technologies; there is interactivity with the instructional material; there is provision for student support and communication channel; acquisition of knowledge, projects and learning by doing; and students are assessed according to the principles of ODL.

However some experts have suggested improvements to be made on the following: (1) o*nline distance learning adaptation and integration* since some functionality is limited and not easy to adopt; (2) the *user interface* and *use of technologies* that is to add video and flash presentation aside from Powerpoint; (3) the *communication channel* by adding tutorial sessions, (4) the *acquisition of knowledge,* that is to provide more support for the personal styles and cognitive levels of learners by providing enough exercises and hands-on practice; and (5) assessment according to the principles of ODL.

Revisions were done to improve the instructional design and usability of the SciTeach course. This includes the presentation of objectives per module, addition of sample answers on assignments to be submitted, another sample thematic unit plan, a tutorial lesson on navigating through the SciTeach course and a CD-ROM to accompany the course.

The cost for the development of the SciTeach course is PhP 56,251.00, while for the delivery is PhP 10,263.00, totaling to PhP 66,514.00. With the aforementioned amount and considering the all benefits offered and its usability, it can be said that the course is cost-effective.

It is recommended that: Trainings delivered using the online learning approach may utilize the SciTeach instructional design; since experts agreed that the course has a good instructional design; SciTeach course developed be evaluated for effectiveness through a pilot study; another study be conducted to evaluate the user interface of MOLE since during evaluation of the

SciTeach course the user interface of the course can be affected by MOLE interface; finally, that a separate study be conducted to explore further the costs and benefits of online learning course offerings.

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