Applying Prototyping Method on Web-based Course Development

Jui-Chen Yu, Lung-Hsing Kuo, Hsieh-Hua Yang, Wen-Chen Hu, Hung-Jen Yang

Abstract— The purpose of this study was to design a web-based teachers' in-service course for creating teaching material for Emerging Technology Learning offered by the High-Scope Project. For coping with new contents brought by fast advancing technology, education system should provide ways to integrating that new information of emerging technology into our curriculum for preparing students with up-to-date knowledge. There is a need to create a course for teachers to review how to creating teaching materials of emerging technology. A fast prototype method was adopted for creating the course. For further reusing on-line course components, the SCORM packaging technique was applied to create course ware from power-point file into SCORM packages. The Ministry of Education Digital Materials Evaluation Standard was used for verifying the course. The standard requirements were met according to two evaluators' response and the reliability was reached at 0.90 levels. An on-line course was established upon the moodle platform and presented as conclusion.

Keywords—SCORM, Quality of On-line Course, High Scope Curriculum Project, In-service Course, Emerging Technology

I. Introduction

Web-based training could provide on-job training in a flexible way. For education, teachers are required learning for enhancing education activities. Technology education is a subject area of common education and provides learner the opportunity of accepting technology. Innovative technology grows everyday and the information and knowledge of technology expands, too. Systems of technology in some areas are even exploded, such as energy & power technology and information & communication technology. In science education, how to integrating emerging technology into formal education becomes a concern. Education reform acts in Taiwan pointed out this trend and raised a "High Scope Curriculum Development" project to foster teachers to design teaching material and learning activities of emerging technology.

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There is a need to design a web-based learning activity for promoting teachers with information about how to integrate emerging technology into formal education. This study intended to demonstrate how to apply prototyping method on web-based course development.

II. Problem Formulation

The progress of curriculum innovation could be monitored with certain domains. A web-based learning activity should meet certain criteria and with the flexibility worked on different platform.

The purpose of this study was to design a web-based course for teachers to learning how to integrating emerging technology into formal high school technology education.

The results of this study would provide teachers in-service training service and promote high-scope curriculum development.

The findings of the research would serve as a guideline to discover the effectiveness of the prototyping system design method used on developing web-based course.

A. Emerging Technology

At the heart of a knowledge-based economy are the so-called 'new technology industries', which exploit science and technology for industrial and social purposes in a way which revolutionary. In essence, they involve the manipulation of materials at the atomic and molecular level. This requires a variety of refined engineering techniques applied to knowledge of the fundamental materials and disciplines concerned, whether based in physics, chemistry, biology, energy or information. In many instances, this also means a fusion of different sciences and technologies.

This combination of advanced engineering techniques and fundamental science, together with the fusion of sciences and technology, has enormous implications for skills. At the highest level, and especially during the early stages when the fundamental properties of the new technology are being worked out, scientists have to be able to work across disciplines. This implicates the emerging technology.

Further downstream, as the basic science and technology become established, and companies start to solve the technical problems of making things, they need people who can work within the new technology and apply established production technologies and disciplines in fabrication and assembly.

Educational system should face this need of learners. There is a need to integrate emerging technology into general education.

B. Technology Education

Technology education is a subject of studying technology in which learners could learn about the context, process, and knowledge related to technology[1].

In Taiwan, technology education is a subject in compulsory education. Technology is human innovation in action. It involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities[1].

Technology Universal Model provides us the foundation that technology learning should be based upon logical context. Technology is a term that has outpaced the definitions commonly found in home and library dictionaries.

R. Wright, E. Israel, and D. Lauda define technology in a decision-maker's guide to technology education, as that a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made environment[2]. They also identified technology as having many facets including that of being organized around the engineering disciplines. They stated the following:

Technological literacy is much more than just knowledge about computers and their application. It involves a vision where each citizen has a degree of knowledge about the nature, behavior, power, and consequences of technology from a broad perspective. Inherently, it involves educational programs where learners become engaged in critical thinking as they design and develop products, systems, and environments to solve practical problems. Through technology, people have changed the world. In the drive to satisfy needs and wants, people have developed and improved ways to communicate, travel, build structures, make products, cure disease, and provide food. This has created a world of technological products and machines, roadways and buildings, and data and global communications. It has created a complex world of constant change.

Each technological advance builds on prior developments. Each advance leads to additional potentials, problems, and more advances in an accelerating spiral of development and complexity. The acceleration of technological change, and the greater potential and power that it brings, inspires and thrills some people, but confuses—even alienates—others. Many people embrace technological change, believing that through technology their lives will be made easier. They see the growing ability to solve age-old problems ranging from food supply to education and pollution.

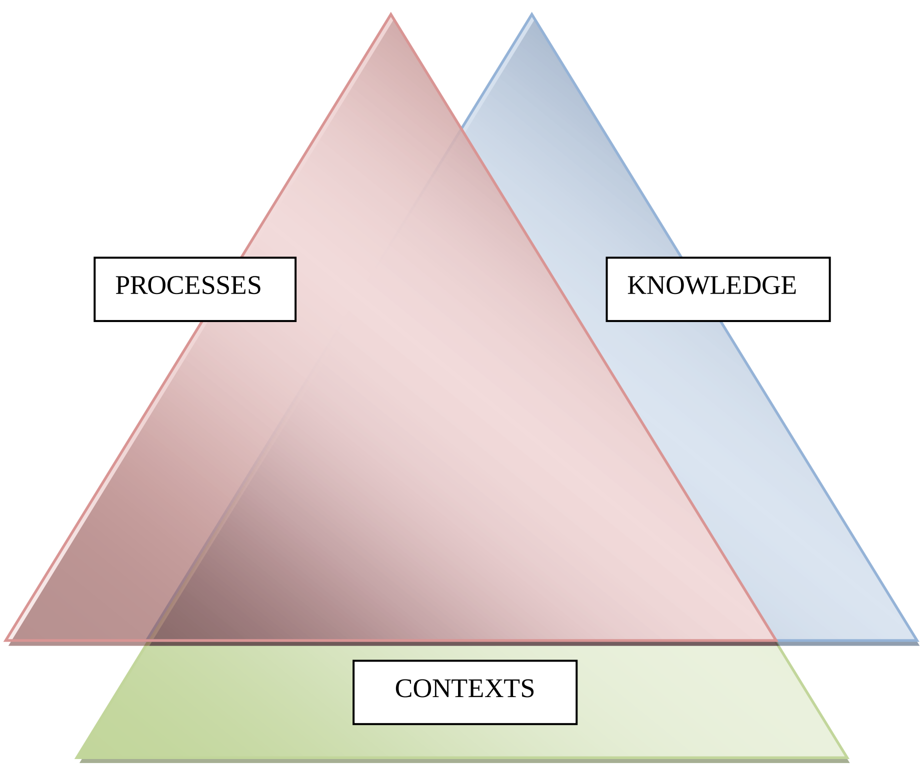

Fig. 1 Technology Universal Model, editing from ITEA[1].

A rationale and structure for the study of technology has been presented here that should assure that everyone can gain the foundation they need to participate in and adapt to today's ever-changing technological world. These materials should be compatible with the emerging standards for technology education. It is hoped that this will encourage technology education leaders to develop new curriculum materials at the state and local levels.

Technology education, as presented here, must become a valued subject at every level.

People make decisions about technological activities every day. However, the growing complexity of technological systems means that all technological decision-making should include an assessment of the impacts and consequences of an implemented or proposed technological system.

All technological activity impacts humans, society, and the environment. Moreover, technological activity involves tradeoffs and risks. Decision makers should understand real vs. implied risks associated with technological developments.

Erich Bloch, past Director of the National Science Foundation, said that, "Technologically literate people should be able to read a newspaper or magazine article and react to those articles related to technology on a basis of some understanding, not on a basis of emotion." [12]

C. Web-based Learning

Web-based learning comprises all forms of internet supported learning and teaching. The information and communication systems whether networked learning or not, serve as a specific media to implement the learning process.[15]

The term will still be utilized to reference out-of-classroom and in-classroom educational experiences via technology, even as advances continue in regard to devices and curriculum.

Web-based learning is essentially the computer and network-enabled transfer of skills and knowledge. Web-based learning applications and processes include mobile-learning, computer-based learning, virtual education opportunities and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. It can be self-paced or instructor-led and includes media in the form of text, image, animation, streaming video and audio.

Abbreviations like CBT (Computer-Based Training), IBT (Internet-Based Training) or WBT (Web-Based Training) have been used as synonyms to web-based learning. Today one can still find these terms being used, along with variations of learning activity such as web-learning, Elearning, and eLearning. The terms will be utilized throughout this article to indicate their validity under the broader terminology of web-based learning.

As an increasingly powerful, interactive, and dynamic medium for delivering information, the World Wide Web (Web) in combination with information technology (e.g., LAN, WAN, Internet, etc.) has found many applications. One popular application has been for educational use, such as Web-based, distance, distributed or online learning.

The use of the Web as an educational tool has provided learners and educators with a wider range of new and interesting learning experiences and teaching environments, not possible in traditional inclass education[13]. Webbased learning environments have been developed mainly by instructional designers using traditional instructional design models such as the instructional systems design [14], cognitive flexibility theory [15], and constructivist learning environment [16].

D. SCORM

SCORM stands for Sharable Content Object Reference Model. SCORM is a suite of technical standards developed by the Advanced Distributed Learning (ADL) initiative to develop common specifications and standards for technology-based learning deployed over the internet.

These standards enable web-based learning and content management systems to find, import, share, reuse, and export learning content in a consistent manner. In addition, it allows user tracking and reports to be generated based on learning objectives. Essentially, SCORM standardized the method of communication between eLearning courses and SCORM conformant learning and content management systems.

Table 1 Objectives of SCORM

Objects	Definition
Accessible	Content can be identified and located when it is needed and as it is needed to meet training and education requirements.
Durable	Content does not require modification to operate as software systems and platforms are changed or upgraded.
Interoperabl e	Content will function in multiple applications, environments, and hardware and software configurations regardless of the tools used to create it and the platform on which it is delivered
Reusable	Content is independent of learning context. It can be used in numerous training situations or for many different learners with any number of development tools or delivery platforms.

E. Objects of SCORM

The objectives of developing SCORM are listed as follows:

- Accessibility

- Adaptability
- Durability
- Interoperability

An on-line learning content should be easy to find based on the classification of the content. User should be able to locate and access learning components from one remote location and deliver to other locations. It is also required to be tailored instruction to individual and organizational needs. Content managers should be able to add new content without much endeavor or excessive price. A learning course should be affordable in the way to increase efficiency and productivity by reducing the time and costs involved in delivering instructional content.

A learning content should be durable, regardless of changes of evolutions in technology. This means that new content should be added to existing content without costly redesign, reconfiguration or recording. The content also is required to run on different learning and content management system. This means that instructional components developed in one location can be used or combined with another set tools or platform in another location.

A learning content should be extracted into elements as modules and re-arranged them into a new course, application or context.

F. Design

The study design for this research is based on the ADDIE model ASSURE model. ADDIE up to ASSURE takes a linear perspective: they describe the instructional development process as a structured and orderly step-by-step activity which could e characterized by a progressive advancement through

- Analysis,
- Design,
- Development,
- Implementation and
- Evaluation

or

- Analyze learners,
- State standards & objectives,
- Select strategies, technology, media & materials,
- Utilize technology, media & materials,
- Request learner participation,
- Evaluate & revise; the process also includes a cycle revision for each edition or delivery of the learning[7-9].

They offer clear guidance[10], emphasize the intrinsic logic of design, and rely on two main assumptions:

1. The assumption of quality information: the designer can work on complete information (from the Analysis phase) and the designer can rely on the fact that the instructional context is stable (i.e., there are no unforeseen events)
2. The assumption of expertise: the designer can master the process and will not make errors, and all the team members and stakeholders will give their contributions as required, at the right moment and in a clear and unambiguous manner
3.

The subject matter expert occupies a critical role in the success or failure of any instructional design project. Ideally the subject matter expert can save the developers vital production time by providing annotated and structured documentation that captures how concepts and skills fit together in a given piece of curriculum.

Although subject area knowledge acquisition has long been recognized as the "long pole in the tent", during development of courseware, the process for collecting the vital content data has been based primarily on unstructured interviews and focus groups which often result in unclearly specified requirements.

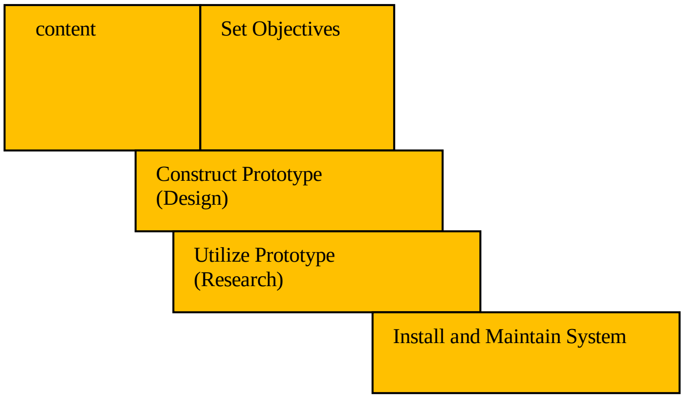

Fig. 2 Tripp and Bichelmeyer rapid prototyping instructional system design model

Tripp and Bichelmeyer [11] define a model (Fig.2) that occurs in a rapid prototyping environment, when prototyping is specifically used as a method for instructional design. The overlapping boxes are meant to represent the fact that the various processes do not occur in a linear fashion. In other words, the analysis of needs and content depends in part upon the knowledge that is gained by actually building and using a prototype instructional system."[10]

With the addition of the rapid prototype phase, the value of the ADDIE model for technology-based training is greatly enhanced. The prototype overcomes the limitations of the traditional ADDIE approach in that it involves all team members earlier in the project cycle, and enables both the client and students to provide early feedback. This approach to rapid courseware prototyping can reduce the time required of programmers, instructional designers, authors, and subject matter experts, while making that time spent more focused and useful for the courseware design and development process.

III. PROBLEM SOLUTION

Based upon the fast prototyping steps, on-line course was identified, designed, constructed, conducted and maintained.

A. Needs of the Course

The course needs was identified as follows:

- Provide high-school teacher on-job training on developing course materials for technology education with emerging technology content of green energy and cloud computing.
- Based upon the developed course material, provide high-school teacher on-job training on developing learning activities for technology education with emerging technology content of green energy and cloud computing.

Fig. 3 Moodle Platform

B. Objectives of the Course

The course objectives were identified as follows.

- Provide high school teachers with the experience of analyzing curriculum standard of high school technology education.
- Provide high school teachers with the experience of analyzing issues of emerging technology
- Prepare high school teachers with the ability of proposing learning goals
- Provide high school teachers with the experience of compile teaching materials based upon both learning goals and emerging technology contents
- Provide high school teachers with the experience of layout learning activities based upon both learning goals and learners' characteristics

C. Constructions of the Course

The structure of the course could be divided into three components.

1. Analyzing curriculum for integration of emerging technology
2. Emerging technology contents selecting as learning experience
3. Learning activities designing

In the first session, technology education curriculum and high-scope project goals would be introduced. How to evaluate suitability of integrating emerging technology would be learned. Joining emerging technology into current technology education curriculum to meet the original learning goals would be the core concept to be hold by the teachers. The time and substitution content should be identified.

The purpose of learning was to build learners with the ability to analyze issues of emerging technology and to integrate those selected contents into formal learning.

In the second session, technology education theory model was provided as a tool for deconstructing emerging technology for selecting learning experiences. The universal of technology model was introduced to teachers. A hand-on work shop was hosted for teachers to do the material selection. Formal documentations of green energy and cloud computing published from authorities were collected as data pools and provided for teachers in electronic and paper forms.

The purpose of learning was to build learners with the ability to follow the learning goals and technology attributes defined by the technology universal model to select raw material of emerging technology and organize those selected learning experiences according to students' needs. Each teacher should finish their own version of teaching material of emerging technology.

In the third session, technology education theory model was provided as a tool for design learning activities based upon teaching materials of emerging technology. The technological method model was introduced to teachers. A hand-on work shop was hosted for teachers to do the learning activity design.

The purpose of learning was to build learners with the ability to follow the learning goals and technology activity attributes defined by the technological method model to organize learning for high school students to learn technology education. Each teacher should finish their own version of teaching activities of emerging technology.

SCORM packages were built based upon power point files, pdf files and interactive questions.

D. Install and Maintain System

A moodle platform was applied for installing the on-line learning course. In Fig. 3, the web page was shown with all activities.

Fig. 4 Discussion Board

In Fig. 4 , the discussion board was provided a communication path between instructors and learners.

Fig. 5 One of the SCORM Package

In the Fig. 5, the layout of a SCORM package is shown. The frame could be adjusted. The communication between platform and SCORM package could be managed.

In the Table 2, learning resources are listed by the name. In this session, learning focused on the initiation information about integrating emerging technology into formal learning.

Table 2 Learning Resources for the first session

Title
Learning Goals
Exploring the necessity of integrating emerging technology into technology education
Attachment 1. Senior High School Curriculum Guideline
Attachment 2. Curriculum Guideline of Technology Education
Interactive Practice Questions
References & full text

In the second session, learning focused on the principles of selecting contents of technology education. In Table 3, learning resources are listed by their title.

Table 3 Learning Resources of the 2nd session

Title
Exploring the principles of selecting technology contents for curriculum materials
Attachment 1.Technological Literacy for All
Emerging Technology Content Analysis
Standard of Green Energy – Main Referenced Materials
Definition of Green Energy – Government Web Side of Reusable Energy
Green Energy Instructional Materials-NASA Educational Materials
Green Energy Instructional Materials-Department of Energy, Energy efficiency & renewable energy
Green Energy in NSC International Cooperation Sci-Tech Newbrief
Standard of Cloud Computing- Main Referenced Materials
Cloud Computing in NSC International Cooperation Sci-Tech Newbrief
Communication Technology Reference Book for Textbook Layout

In the Table 4, learning resources for the 3rd session are listed by their title.

Table 4 Learning Resources of the 3rd session

Title
The procedure of compiling emerging technology teaching materials
Exploring Characteristics of Multi-culture Learning Activity
Attachment 1. Collaborative Problem-Solving for Equity and Justice (A 6-Step Model)
Attachment 2.Five approaches to social justice activism
Attachment 3.Five Shifts of Consciousness for Multicultural Educators
Attachment 4.Promoting Educational Equity- balance between contemporary strategy and multi-culture education
Attachment 5.Guidelines for Equity Issues in Technology Education

In the fourth session, the learning focused on activities design. In the Table 5, learning resources are listed by their name.

Table 5 Learning Resources of the fourth session

Title
Learning Activity Design
CIPP Evaluation for Emerging Technology Curriculum Development
Attachment 1. The CIPP Model for Evaluation
Attachment 2. An evaluation of the curriculum
Link for submit evaluation tool of green energy
Link for submit evaluation tool of cloud computing
Reference Books of Emerging Technology

In the Fig. 6, one screen of the interactive questioning procedures of the on-line SCORM package is presented.

Fig. 6 Interactive Question

E. Evaluation Standard and Results

There were four dimensions of the Ministry of Education Digital Materials Evaluation Standard.

1. Contents & Structure
2. Material Design
3. Auxiliary Design
4. Media and Interface Design

According to standard, all requirements of four dimensions were met and the evaluators' agreement was calculated at 0.9 levels, 26 out of 29 items. The results of each dimension were described in following sessions.

Table 6 Summary table of evaluation

Dimension			Evaluator 1		Evaluator 2		Reached Items
	R	O	A	A+	A	A+	
1	7	3		10	1	9	9
2	6	3	1	8	2	7	8
3	1	3		4		4	4
4	5	1		6	1	5	5
							26

R: required items
O: optional items

F. Contents & Structure

The evaluation results of contents and structure are illustrated in this section.

- The on-line course web page would explain subjects and topics clearly. It provided all units' name, time plan, and user information.
- The web page provided learner with practical objects in cognition, skill, and attitude.
- The course materials covered all learning objects listed for this course.
- The level of both material and potential learner were matched.
- The content of materials was correct.
- The organization of material was in logical order and divided into specific units.
- The amount of material in each unit was even and appropriate.
- The reference and citation were listed clearly.
- It provided recent version of documents.
- It provided related resources for further study.

G. Material Design

The evaluation results of material design are illustrated in this section.

- The on-line course web page would initiate learner's motivation. It provided active information to draw the learner's attention.
- The material provided clear guide of how to join learning activities.
- Examples provided in the material were useful and appropriate.
- There were some interactions for learner to practice their thinking and skill.
- The page provided evaluation for learners to inform their own progresses.
- There were channels for feedbacks.
- The page provided suggestions of each learning session.

H. Auxiliary Design

The evaluation results of auxiliary design are illustrated in this section.

- The on-line course web page would be with detail browsing information. It provided identical layout, button directions, website map, and operating instructions.
- The material provided notable learning progress records.
- The system provided keyword index service.

I. Media and Interface Design

The evaluation results of media and interface design are illustrated in this section.

- The media quality of on-line course web page would be nice and with high quality in both vision and audio.
- The media could help learners in both vision and audio recognition and distinguishing.
- The material provided screen layout in outlook, color, function, and position.
- The operating interface was well designed in convenience, reliable and unify.
- The browser works well on the course material.

IV. CONCLUSION

The purpose of this study was to design a web-based teachers' in-service course for creating teaching material for Emerging Technology Learning offered by the High-Scope Project. A fast prototyping method was adopted to conduct this study.

The course was designed to offer teachers the opportunity of learning how to design emerging technology teaching materials and organize learning activity for technology education.

This study fulfills the need of demonstrate create a course based upon prototyping method. A fast prototype method was adopted for creating the course. For further reusing on-line course components, the SCORM packaging technique was applied to create course ware from power-point file into SCORM packages. The Ministry of Education Digital Materials Evaluation Standard was used for verifying the course. The standard requirements were met according to two evaluators' response and the reliability was reached at 0.90 levels. An on-line course was established upon the moodle platform and presented as conclusion. In-service training for teachers might use this prototyping method to create up-to-date curriculum for training teachers with the ability to cope with emerging technology education contents [17-19].

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