The Design and Implementation of a Web-based Teaching-Learning Model for Information Communication Technology Application Education

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Abstract Advances in information communication technology (ICT) require new paradigms in every aspect of our society. In this sense, schools are responsible for educating students to solve real-world problems with ICT. However, schools have not provided quality education to students for learning ICT and applying it. It is thus necessary to develop an ICT instruction model for students. One of the popular instruction models for Web-based instruction is the project-based model (NetPBL). It is a student-centered model in which students take initiative in all study processes. The model includes inquiry activities of areas, such as subjects, problems, and issues, and presentation activities of study results. The model also encourages interactions among students for achieving common goals. In this paper, we present an instruction model called Web-based instruction model for ICT (WICT) which provides four major enhancements to the existing project-based model. First, our model emphasizes learners' autonomy and helps them perform diverse learning activities. Second, learners can decide the learning objectives and strategies for themselves, and participate in the evaluation process of their study results. Third, by experiencing active information sharing and interactions, learners can acquire information communication ethics such as the utilization of sound information, network communication etiquette, and copyright protection. Fourth, learners can develop their creativity and problem solving abilities in the process of finding proper information, analyzing it, and eventually creating new information for their objectives. We then present the implementation of our proposed model in an example application of elementary school's social study courses.

Keywords: Web-based Instruction, Information communication technology

1 Introduction

In a knowledge-based society, ICT can support synthetic management of tremendous data that can be utilized by human. ICT is essential to the process of

collecting, processing and analyzing data. In the field of education, ICT can provide many benefits. It can overcome the problem of time and space limits existing in traditional classrooms, provide new information to both students and teachers, support students' individual study, and provide authentic circumstances [2,4,6,11]. New paradigms in education, such as the one that calls for practical use of Internet, require improvements in computer literacy, computer ethics, and teaching-learning methods using ICT.

The objective of ICT education is to increase students' information literacy capability necessary for the knowledge and information based society and encourage them to apply their capability to study activities as well as daily life [6]. Therefore, both information literacy and applicability are important in ICT education. However, only improving information literacy capability has been emphasized in schools. Currently, to our best knowledge, there is only one formal instruction model for ICT application education [9]. The model is good for only courses whose problem-solving process and solutions are well defined. However, it may not work well for other types of courses that require complex thinking process and creativity. Thus, before the trial of ICT application education, it is very important to develop an ICT instruction model for students.

In general, any instruction model can be used to ICT application education. Among various instruction models, the project-based model is the most suitable due the following reasons [5]. First of all, the model allows students to take initiative through the study process. Second, the model includes inquiry activities of areas, such as subjects, problems and issues, and presentation activities of students' products. Finally, students are supposed to correct their misunderstandings through various interactions among students.

In this paper, we present an instruction model for ICT application education. Our model is based on the existing project-based model but includes the following additional features. First, it emphasizes learners' autonomy and distinctive characters, and helps them perform diverse learning activities. Second, learners can decide the learning objectives and strategies for themselves, and participate in the evaluation process of their study results. Third, by experiencing active information sharing and interactions, learners can acquire information communication ethics, such as the utilization of sound information, network communication etiquette, and copyright protection. Fourth, learners can develop their creativity and problem solving abilities in the process of finding proper information, analyzing it, and eventually creating new information for their objectives. And fifth, learners can obtain the opportunity for widening their ways of thinking by taking advantage of ICT, which overcomes the limitations of time and space in the traditional classroom. We then present the implementation of our proposed model in an example application of elementary school's social study courses.

This paper is organized as follows. In Section 2, we present the concept and necessity of ICT education, and supporting tools for ICT application education. In Section 3, we discuss NetPBL. In Section 4, we present our model for ICT application education. In Section 4, we describe the implementation of our model in an elementary social study course. Finally, In Section 5, we give conclusions and further research issues.

2 ICT Education

2.1. Concept and Necessity of ICT Education

ICT education implies education based on computer and communication tools for current knowledge and information society [12]. ICT education can be classified into two categories: ICT literacy education and ICT application education. ICT literacy education (also called computer education) means education about computer and information communication. On the other hand, ICT application education is education about applying ICT to courses in various subjects such as math, science, and foreign languages.

The objective of ICT education is to provide capability for collecting and analyzing information necessary to each person, and let everyone use this capability to enjoy active and creative life [12]. In order to achieve this objective, ICT should be used to teach every class in school. Currently ICT education is more concerned with teaching how to apply ICT to each class rather than simply teaching how to use computers [7].

2.2. Teaching-learning Activity Types for ICT Application Education

Activity types for ICT application education can be classified into 8 categories as shown in Table 1 [7].

Activity Type	Concept
Search information	Search information through visiting the Web site, reading CD-ROM title and printed materials, and exchanging ideas with others
Analyze information	Analyze information using various methods, such as survey or experiment, and forecast conclusions based on the analyzed information
Guide Students	In this type, teachers lead most study activities based predefined plans. Teachers are supposed to provide CD-ROM titles, presentation materials or Web page for students.
Discuss on the Web	Discuss on the specific topic with approved participants or anybody else using Chat, BBS (Bulletin Board System) and e-mail
Collaborate on the Web	Exchange ideas on common concerns with students from different regions and share the results
Communicate with Experts	Communicate with experts, parents as well as other teachers on the Web to obtain knowledge for problem-solving
Support E-pals	Exchange ideas with students from different regions using e-mail
Produce results	Produce results and publish them for others. The published forms include reports, presentation files or Web pages

<Table 1> Teaching-learning activity types for ICT application education

2.3. Supporting Tools for ICT Application Education

The supporting tools for ICT application education and their characteristics are explained in Table 2 [7].

Supporting Tools	Characteristics
Word processor, Desktop publishing package, and presentation software	-Improve students' understanding and help students present their results
Graphic and animation	-Materialize abstract concept and provide clues for study -Provide intuitive recognition and motive to students
Internet Search Engine	-Provide necessary information for achieving study objectives
E-mail, BBS, on-line chat	-Help students exchange ideas with many people and understand various cultures
Simulation	-If experiencing real situation is dangerous, expensive and time-consuming, simulation let students experience virtual reality
Database and Spreadsheet	- Help students analyze results and verify their original hypothesis

<Table 2> Supporting tools for ICT application education and their characteristics

2.4. Related Work

In the literature, a teaching-learning model for ICT application education has been published in [9]. The model is based on the problem-based model. The teaching-learning model has the following five stages as shown in Table 3.

Stage	Substage
Introduction	- Introduce course - Create good atmosphere for students - Convey basic concepts
Presenting problems and information	- Present problems - Introduce assignments - Provide information and let student observe - Group activity
Problem solving	- Inquiry activity - Exchange ideas and converge those ideas - Provide supplementary information - Search information - Contact experts - Induce solutions - Induce conclusions
Presenting results	- Produce results

	- Present results
Conclusions	- Organize results - Contact experts - Apply results - Self-examine - Notify next topics

<Table 3> A teaching-learning model for ICT application education [9]

In this model, teachers have control over students' activities. In other words, students are supposed to follow their teacher's instructions and induce conclusions based information provided by the teacher. Thus, the above model is focused on solving problems whose solutions are predefined. That is, the model is good for only courses whose problem-solving process and solutions are well defined. However, it may not work well for other types of courses that require complex thinking process and creativity.

3 NetPBL

3.1. Concepts and Characteristics of NetPBL

NetPBL is a teaching-learning method that helps students collect various information by communicating with others on the Internet, and finish specific projects [8,10].

The characteristics of NetPBL are as follows [3,8].

- It deals with project with undefined solutions or many solutions.
- It accepts gracefully mistakes made by students in the course of the project.
- It lets student utilize various knowledge from diverse areas in order to finish the project.
- Students are responsible for their project and are supposed to solve problems encountered during the project.
- Students are evaluated regularly and supposed to reflect their study activities regularly.

3.2. Significances of NetPBL

The significances of NetPBL in education are summarized as follows [13,14,15].

First, it improves learning strategies and thinking skills. Instead of covering many superficial topics, it encourages students to work on a problem in depth. For achieving a goal, students are also given some freedom to follow what they like instead of a predefined sequence. NetPBL also supports life-long learning. Thus, students are supposed to think about a topic and exchange ideas continuously after the project is over. In addition, NetPBL encourages students to be active all the time. They are supposed to collect, organize and analyze information for themselves. They are also required to contact anybody if necessary. The NetPBL also encourages cooperative learning. A meditated conclusion can be reached by cooperative work through various

interactions.

Second, it supports contextual learning. In NetPBL, students are encouraged to experience real-world problems. This makes learning less abstract and more connected to real life. In [1], it is argued "when students deal with authentic problems, it helps them to construct highly developed schema that contributes to an increased ability to solve problems".

Third, it emphasizes individualization. That is, it recognizes that different people learn best in different ways. NetPBL helps to support individualization with various options for representing feedback and discourse, etc.

Fourth, NetPBL emphasizes active participation.

4. The Proposed Model

4.1 Background

As we discussed in Section 3, NetPBL is a very useful instruction model in that it emphasizes students' active participation, various interactions, and evaluation for processes as well as products. On the other hand, the objectives of ICT educations are to increase students' applicability of ICT, students' problem-solving ability, and acquiring ethics on information communication [12]. In this sense, we believe that NetPBL provides the theoretical background for ICT application education.

In this work, we propose an instruction model for ICT application education. Tables 4 and 5 show the stages of NetPBL and our model, respectively.

NetPBL	
Stage	**Substage**
Start project	- Decide starting point - Plan study topics - Make question lists
Develop project activities	- Get ready for field study - Make observation - Ask experts for any question
Finish project	- Finish project - Individualize new knowledge

<Table 4> Stages of NetPBL

The proposed model	
Stage	**Substage**
Plan	- Introduce project topics - Decide audience - Suggest evaluation standards - Organize topic Web - Make question lists
	- Organize team members - Plan project

Perform	- Advertise project - Select collaborators - Survey and discuss - Produce results
Evaluate	- Present and share results - Evaluate and reflect

<Table 5> Stages of the proposed model

4.2 Description of the Proposed Model

In this Subsection, we describe our model in detail. That is, we provide activity types, tools and media necessary for each stage, number of persons, and place for each activity. Table 6 shows each activity and its subsequent activities in the proposed model.

Stage	**Substage**	**Activity type**	**Tools and media necessary**	**Number of persons**	**Place for activity**
Plan	•Introduce project topics •Decide audience •Present evaluation standards •Organize topic Web •Make question lists	•Provide necessary information •Search information •Discuss on the Web	•Web search engines •Presentation software •Graphic and animation •BBS •On-line chat	Large group /individual study	Classroom/computer room
Perform	•Organize team members •Plan project •Advertise project •Select collaborators •Survey and discuss •Produce results	•Search information •Analyze information •Discuss on the Web •Perform collaborative work •Exchange ideas with experts •Exchange ideas using e-mail •Make conclusions	•Web search engines •Desktop publishing software •Word processor •Presentation software •Graphic and animation •E-mail •BBS •On-line chat •Database and spreadsheet	Small group/individual study	Classroom/computer room

Evaluate	•Present and share results •Evaluate and reflect	•Discuss on the Web •Exchange ideas using e-mail	•Presentation software •On-line chat •BBS •E-mail	Large group/small group/individual study	Classroom/Computer room

<Table 6> Stages and their subsequent activities of the proposed model

(1) "Plan" Stage

a) Introduce project topics

Teachers need to select project topics and describe project outlines, and present study objectives to students. Also, teachers have to present details for the project. When project topics are to be determined, the following should be considered: the topics are to improve curriculum and reinforce attainment of Internet technology. It is noted that students as well as teachers need to participate in deciding project topics.

b) Decide audience

In the traditional class, study activities and results are open to only students and teachers in classroom. But, with aid of Internet technology, students' activities can be open to various people. In addition, those people can even participate in students' projects. That is, they can cooperate with students and provide help to students.

c) Present evaluation standards

Before starting a project, it is necessary to present evaluation standards for the accurate assessment of students' performance. Evaluation methods include paperwork, observation, and mutual evaluation. Especially, rublic has long been used to evaluate project activities and results [16]. A rublic means a set of criteria that define important parts of a project to be evaluated. Each criterion in turn defines several different grades of completion or competence. A rublic is used to provide clear guidelines to a reviewer how to evaluate a project. Since each criterion is clear and objective, different reviewers can make almost the same conclusions.

d) Organize topic web

The topic web is used to arrange words related to project topics made by teachers in the form of web pages. The topic web helps students guess range and size of activities in a project [17].

e) Make question lists

After the topic web is built, question lists are constructed by students. These lists are to help students collect questions they want to investigate in the course of the project. Teachers are supposed to put those lists on BBS.

(2) "Perform" stage

a) Organize team members

Depending on the project size, a group can have various members. In order to maximize interactions among members, each group is recommended to have 2-6 members. If more members are participated, some members may be inactive or isolated from others. Also, it is important to assign accurate duties to each member.

b) Plan project

Students are supposed to select subsequent project topics and complete project plans. Since success in a project depends on this step, teachers need to guide students carefully for completing the project plans. Before starting the project, students themselves need to examine and criticize the plan. This phase consists of the following two steps:

i. Decide project objectives, assignment, and results

Each group decides subsequent topics and decides project objectives, assignment, and results. Each group also determines how to recruit collaborators and how to compensate for their participation.

ii. Decide schedule

Decide the starting day and ending day for the project. Also, determine participants' application deadline and announce the deadline.

c) Advertise project

In order to find collaborators for a project, it is important to advertise the project broadly. In order to do this, the project title, and the project information, such as study objectives, project description, project schedule, participants' qualification, roles of participants, rewards for participants, contact information, and project manager, need to be advertised on the Web.

d) Select collaborators

Select qualified persons among participated collaborators for the project and share their contact information such as mailing address and e-mail address. Also, let students and selected collaborators know each other and find out issues that may occur during the course of the project.

e) Survey and discuss

In the survey activity, students are supposed to collect and organize information necessary for the project. Students find the relevant information on the Web or through exchanging e-mails with experts. Also, in the discussion activity, students can exchange and share opinions on the project. In addition, in this step, students are supposed to have off-line meetings regularly and report main events occurred in their team. Also, let team leaders report the project progress to all classmates.

f) Produce results

In this step, students should submit their results which are in the form of books or Web publications.

(3) "Evaluate" stage

In principle, students themselves need to reflect and evaluate their results and activities. In this case, teachers should give advice or encouragement instead of criticism. Mutual evaluation among students is also recommended.

a) Present and share results

Teachers and students present the project results and decide date to be published on the Web, roles of each participant, and presentation format, etc. This presentation provides very useful information to collaborators and audience. By doing so, results and ideas can be shared.

b) Evaluate and reflect

Based on evaluation standards, all processes and results need to be evaluated. The evaluation includes two factors. The first factor is to evaluate whether the main objectives and subsequent objectives under each of the main objectives are achieved

or not. The second factor is to evaluate the project results through analyzing the results. After evaluation, students are supposed to reflect what they have done.

5. Implementation and Application of the Proposed Model

We implemented our model in site (http://use.chollian.net/~est718/pbl). Figure 1 shows the teaching-learning site map for our model.

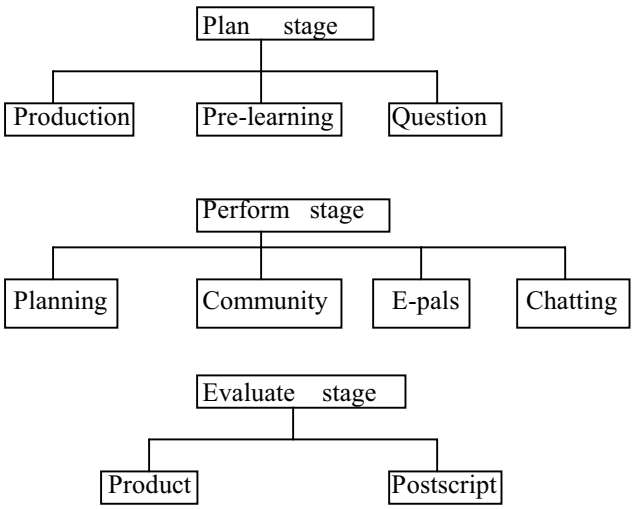

Figure 1. Site map of our model

5.1. Plan stage

Production guides subjects or topics, learning activity schedules, and evaluation criteria that teachers selected through the analysis of the education program and students' interests. *Pre-learning* induces students' experience and knowledge related to study subjects, and introduces useful study sites. In addition, the study of ICT literacy necessary to performing projects is explained.

Question is used for students to post questions that happen during the course of the projects. The contents of a question can be added continuously, and posted questions are reviewed and discussed together at the end of *Question*. Figure 2 and 3 show *Production* screen and *Question* screen, respectively, in our Web site.

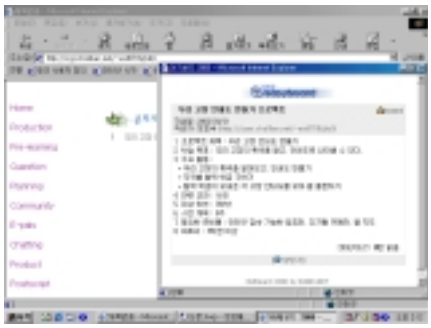

Figure 2. Production screen

Figure 3. Pre-learning screen

5.2. Perform stage

Planning is used for students to turn in a detailed planning report, which explains detail subject selected by individual or a small group. The teachers prepare the planning report forms in advance, and guide the elements that must be included in the final report.

Community is the place where students can share diverse data and information gathered during the course of the projects. Students can also share ideas and discuss in depth with one another. Further, it is used for the regular meetings organized by individual teams in which teams report the major events happened in each team.

E-pals stores e-mails for the communication of external experts, parents, and the higher or lower grade students. Students can be supported to utilize special knowledge when they perform inquiry or research activities.

Chatting is used as a communication channel for the decision-making, and supports discussion activities for assigning roles and problem solving. Figure 4 and 5 show *Planning* screen and *E-pals* screen, respectively, in our Web site.

Figure 4. Planning screen

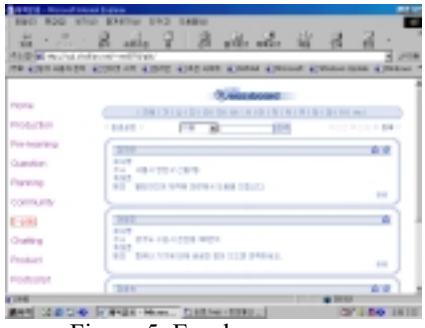

Figure 5. E-pals screen

5.3. Evaluate stage

Product shown in Figure 6 is the place where final results are published on the Web. The posted Web pages are shared with collaborators.

Postscript shown in Figure 7 is used when students want to discuss further on the previous subjects after the project completion. It provides opportunities to develop creative next projects.

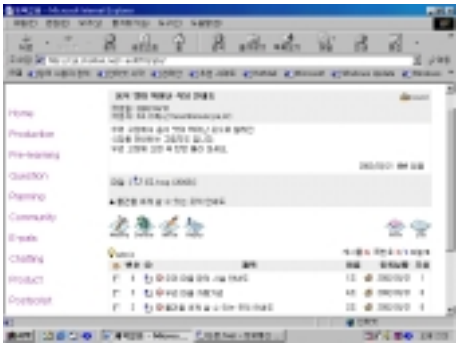

Figure 6. Product screen

Figure 7. Postscript screen

6. Conclusions and Further Work

ICT application education has been a sound social trend. The aim of this paper is to develop a teaching-learning model for ICT application education and illustrate the model's implementation in an example application of elementary school's social study classes. The paper suggests what kind of ICT can be selected at a specific time of learning, and how it can be utilized. In addition, the teaching-learning stages of the learning model are classified, and various ICT utilizing methods for each stage are introduced. As a result, time and effort for the preparation of ICT application education can be reduced.

The effectiveness of this model can be as follows. First, it emphasizes the learner's autonomy and distinctive characters, and helps them perform diverse learning activities, which is different from traditional memory-oriented education in a classroom. Second, learners can decide the learning objectives and strategies for themselves, and participate in the evaluation process of their study results. Therefore, they can enhance self-directed learning abilities. Third, by experiencing active information sharing and interactions, learners can acquire information communication ethics such as the utilization of sound information, network communication etiquette, and copyright protection. Fourth, learners can develop their creativity and problem solving abilities in the process of finding proper information, analyzing it, and eventually creating new information for their objectives. And fifth, learners can

obtain the opportunity for widening their ways of thinking by taking advantage of ICT, which overcomes the limitations of time and space in traditional classrooms.

Even though this paper suggests a standardized learning model, teachers can develop their flexible study plan according to the their experience and study topics. In addition, it is necessary to develop instruction models reflecting gaps of ICT utilizing abilities among learners.

References

[1] Abbey, B., *Instructional and Cognitive Impacts of Web-based Education*, Idea Group Publishing Company, London, United Kingdom (2000)

[2] Carrucan, T., Crewe, T., Matthews, E. & Matthews, S., The Internet Manual for Teachers, Macmillan, Chapter 9 (1998)

[3] Jacobson, M. J., Lesson Learned and Lessons to be Learned: An Overview of Network Learning Environments in the United States of America, Paper presented at the 1997 APEC International Conference on the Utilization of Computer Networks in School, Seoul, Korea (1997)

[4] Eklund, J. & Kwan, V., Enhancing Collaborative Learning In Primary Education Through The Australian Schools Web Challenge, Paper presented at 2000 the Ausweb [Online] http://ausweb.scu.edu.au/aw2k/papers/eklund/paper.html (2000)

[5] Katz, L.G., The Project Approach, ERIC Digest: EDO-PS-94-6, [Online] http://ericps.crc.uiuc.edu/eece/pubs/digests/1994/lk-pro94.html (1994)

[6] Korea Education & Research Information Service, The instruction material for using the Information Communication Technology, Ministry of Education & Human Resources Development (2001)

[7] Korea Education & Research Information Service, Studying and training material for education using the Information Communication Technology, Ministry of Education & Human Resources Development (2001)

[8] Laffey, J., Tupper, T., Musser, D., & Wedman, J., A Computer-Mediated Support system for Project-Based Learning, Educational Technology Research and Development, 46(1), (1998) 73-84

[9] Lee, T., A Teaching-learning Model for ICT Application based on Problem-based Model, EDUNET Journal, KERIS, March, (2001) 45 – 58.

[10] Levin, J. A., Pogers, A., Waugh, M., and Smith, K., Observations on Educational Electronic Networks: The Importance of Appropriate Activities for Learning. The Computer Teacher, 16(8), (1989) 17-21.

[11] Roerden, L. P., Net Lessons: Web-Based Project for Your Classroom, O'Reilly Press (1999)

[12] http://www.eduict.net/

[13] http://24.16.119.79:1444/web/pbl/reform.htm

[14] http://www.globalschoolhouse.org/pbl/finding.html

[15] http://gsh.lightspan.com/web/lib/ed/pbl.htm

[16] http://24.16.119.79:1444/web/pbl/plan/assess.htm

[17] http://project-approach.com/strategic/events.htm