A STUDY ON
IMPROVING INFORMATION PROCESSING
ABILITIES BASED ON PBL

Du Gyu KIM
Dept. of Learning Technology, University of North Texas
3940 N. Elm St., Suite G150, Denton, TX 70607, U.S.A

JaeMu LEE
Dept. of Computer Education,
Busan National University of Education
24 Gyodaero, Yeonjegu, Busan 611736, REPUBLIC OF KOREA

ABSTRACT

This study examined an instruction method for the improvement of information processing abilities in elementary school students. Current elementary students are required to develop information processing abilities to create new knowledge for this digital age. There is, however, a shortage of instruction strategies for these information processing abilities.

This research proposes a method for teaching information processing abilities based on a problem-based learning model, and was tested with elementary students. The students developed an improved ability to create new knowledge and to present relationships with information through the process of problem solving. This study performed experimental research by comparing pre- and post-tests with twenty-three fifth grade elementary students over the course of eight months. This study produced a remarkable improvement in information selection, information reliability, information classification, information analysis, information comparison, and information internalization. This study presents an improved methodology for the teaching of information processing abilities.

Keywords: Problem based learning, information processing ability, blended learning

INTRODUCTION

Because of the development of information engineering, the twenty-first century is being called the Knowledge-Based Society. The lifespan of information and technology is shortened, and it becomes difficult to use information that we learned in school; therefore, the ability to choose appropriate knowledge and re-compose it is needed in authentic problem situations (Evensen, Hmelo, 2000; Jonassen, 2000). Educators find new teaching methods by reflecting on existing school-based teaching methods to meet the demands of the times. One of these new teaching methods is the Problem Based Learning (PBL).To put it concretely, PBL uses authentic problems drawn from the learners' life experiences. It increases the interrelationships of learning materials and allows students to develop a higher degree of thinking ability using in-depth interaction, concrete experience, and clue-compared traditional learning methods used in the course (Barrows, 1994).

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Learners are motivated toward the achievement of learning by the removal of humdrum memorization and are inspired to learn in a spontaneous manner (Aspy D. N., Aspy, C. B, and Quinby, 1993). In addition, PBL develops interpersonal and teamwork skills as it cements group members and invigorates interaction and teamwork in the process of problem solving. It is an improvement on existing traditional teaching methods.

Recently, PBL has developed and is changing with development of ICT and PBL, web-based study (Richards, 2001; Zumbach, Hillers, Reimann, 2004). PBL is student-centered. It emphasizes cooperative learning with other people and solves authentic, complex, and ill-structured problems in a web-based environment (Koschmann, Kelson, Feltovich, Barrows, 1996). PBL based on 'blending' makes it possible to search and share various pieces of information.

It develops new forms as members of the community interact in various ways and learning atmospheres change. It uses e-mail, online boards, synchronous and asynchronous conferences. Learner-learner and learner-instructor interaction becomes active and extends the lesson beyond the classroom because cooperation and communication are needed to solve problems.

It becomes more effective because of the need to develop a process for information searching, for the analysis and solution of the problem and problem solution plan, for verification, arrangement, synthesis and presentation.

There is an abundance of information on the Internet. Students can improve their creativity and problem solving abilities by selecting suitable material, analyzing, synthesizing, and remaking it into new information. We believe that learners expand their thoughts beyond limited learning by using ICT to transcend time and place (Korea Education & Research Information Service, 2004).

It is more useful to select knowledge and information by personal individuality or thought than to simply memorize what is provided to them. Students should have more than simply a quantity of knowledge; that is, 'How much you know?' Instead, information processing abilities - that is, 'Can you make new knowledge using information?' - are what we should be developing. The difficulty is that computer classes are taught as extracurricular activities, and ICT education isn't taught in every school. In this situation, ICT education does not provide concrete examples and ways to improve 'Information Processing Abilities' because it is taught in literacy training classes.

The purpose of this study is to improve information processing abilities through the solving of problems concerned with students' situations using the computer. To improve information processing abilities, the PBL model is applied and combined tasks are presented. Students use computers to solve tasks and improve their information processing abilities in the process of PBL-concerned tasks.

BACKGROUND THEORY

Process of PBL
Scholars (Barrows & Myers, 1993; Fogarty, 1997; Delisle, 1997; and Savery & Duffy, 1995) suggest various processes for PBL. This study takes the Barrows & Myers's (1993) model that is the most typical process among these processes.

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Table: 1 shows the learning steps for PBL based on the Web for improved Information Processing Abilities.

Table: 1
PBL Learning Process Steps

Steps	Content	Caution
Step 1	PBL task presentation	A problem related to life and concerning time should be chosen
Step 2	Making a 'plan for task performance' by team	We should write the data we know, and we should know how to solve the problem.
Step 3	Division of personal tasks	The task should be divided among the persons based on a 'plan for task performance'
Step 4	Personal task performance	There should be instruction information regarding collection, selection, sources, and validity
Step 5	Personal task Presentation in team active time	There should be instruction for the students on how to synthesize and remake collected information into suitable materials through classification, analysis, and comparison in order to solve the problem
Step 6	Team presentation	There should be instruction for the students to learn the various opinions of other team with respect to the solution of the same problem
Step 7	Making a reflection journal	A reflection journal should be made after the team activity

Information Processing Abilities

The Information Processing Abilities are based on the 'Standard ICT skills of elementary-middle school students' as defined by the Korea Education & Research Information Service (Korea Education & Research Information Service, 2004).

Many suggestions are provided. Considering the test group, elementary school students, we define 'Information processes ability' as the ability of the students to discover a problem about subject by themselves; and then research and study the problem as they solve it. In other words, the students set the learning objective, find information by themselves (with the assistance of the teacher), and solve the problem. All of this involves the ability to collect, create, remake information, and internalize it.

Examination of the Literature

Gallagber, Stepien & Rosenthal (1992) found that the problem-finding abilities of students who attended PBL increased in their study concerning the effects of PBL on problem solving. In addition, they indicated that structured problems are not needed in the process of problem solving and problem finding. They suggest that PBL is a way to solve ill-structured problems through compared consideration of structured problems and ill-structured problems. Sage (1996) said that PBL is an education approach for a constructed curriculum and classes on life problems. It is helpful to learners in that it improves critical thinking and cooperation in research and shows the characteristics and the effects of PBL on the learning activities of students as a development and teaching strategy. Most research applied ill-structured problems and target adult learners, so Sage (1996) wishes to discover if ill-structured problems are also suitable for young learners. He has been suggesting follow-up research about how the problems are developed. 43

Achilles & Hoover (1996a) said that students do not have sufficient socialistic ability and time to solve problems through cooperative learning in a study conducted to discover the possibility of PBL as an education innovation in one high school and two middle schools. According to their study, PBL is not an innovation strategy for school education in general, but it is flexible and helps students respect each other and does improve their ability to think through cooperative learning.

Williams (1992) criticizes PBL in a study at a medical college, reporting that, in general, it does not help students to develop strategies for problem solving. He therefore suggests an amendment for elementary and middle schools that provides students with the opportunity to watch the ways in which experts practice in situations. This would help the students to learn effective problem solving strategies more quickly and be more helpful to students than simply applying PBL without such expert and successful examples. He suggests that PBL should be verified with respect to age, motivation level, and the level of achievement of the learners.

Achilles & Hoover (1996b) suggest that the education standards of elementary and middle schools are improved as a result of applying PBL in elementary and middle schools. With PBL, the curriculum is integrated, alternative assessment methods are suggested, teaching methods are improved, and active and cooperative learning is enhanced. Their study, however, suggests that students have difficulties solving in groups when they practiced PBL; it suggests that students need training before PBL is applied. Richards (2001) insists, on the other hand, that PBL classes are very useful as an approach to the integration curriculum using the Web. In particular, he emphasizes that students can do reflection learning and learn overall aspects with respect to the leaning objective. Zumbach, etc. (2004) suggests that there are on-going attempts to integrate the Web and PBL, and to provide dPBL (distributed Problem-Based Learning) courses which integrate PBL, LBD (Learning by Design), and Web-assisted CSCL (Computer Supported Collaboration Learning) on the Web.The literature suggests that, with respect to learning, a new education paradigm is needed. Long-term and continuous PBL instruction is needed in order to develop positive effects and an improvement in information processing abilities. In the process of their study, learners can improve their information processing abilities and find relationships in information; they can structuralize and schematize it. Thus, this study is concerned with real life problems of elementary students and presents various discussion subjects. It focuses on information processing abilities that create new information and development the ability to express relationships in information using the computer.

STUDY METHOD

Subjects and Period of the Study
This study performed with twenty-three fifth grade elementary students over the course of eight months from March 2012 to October 2012, and presented PBL problems eleven times. In addition, an 'e-PBL board' was created and used for this study.

Assessment Method
The prototype for an assessment method to measure 'information processing abilities' based on the 'Standard ICT skills of elementary and middle school students' was made by the Korea Education & Research Information Service (Korea Education & Research Information Service, 2004).

Two computer education experts and one education evaluation expert examined the content validity to assure the validity of the assessment method and suggest any necessary modifications.

Design of the Study

This study focused on experimental research which compared the abilities of the students through pre- and post-tests. The subjects are the test group. This research analyzed the information processing abilities of students before they study. It also analyzed through pre- and post-tests after the students practiced tasks using the PBL process of seven steps based on the PBL model. This study process was: first, reports of learners before applying PBL are analyzed itemizing the information processing abilities and the actual condition as researched. Second, the class homepage for the Web-based PBL was opened and managed. Third, the students were given ICT literacy training on how to solve problems using the computer. Fourth, PBL was performed in order to improve the students' information processing abilities. Fifth, after applying the PBL, the reports of the learners were assessed using the Information Processing Ability Assessment Table and changes in abilities from the pretest to the post-test were ascertained.

Apply PBL Process for Information Processing Abilities

The PBL was based on the most well-known model of Barrows & Myers (1993).

Table: 2
PBL task

Tasks	Task based on the Web	Relation of life
Task 1	The causes and effects of yellow dust on daily life and a solution	Korea issued a yellow dust watch because of the yellow dust
task 2	Ownership declaration of Dokdo by Japan	Japan declared ownership of Dokdo
task 3	Korea-USA FTA	Signing of the Korea-USA FTA
task 4	The oil tanker called the Sea Prince sank off Yeo-su	Visit affiliated sister- school in Yeo-su Kum-o island in June.
task 5	Are there any ways to overcome the destruction caused by typhoons and heavy rains every year?	Destruction caused by typhoons in Korea.
task 6	What is the problem with North Korea having nuclear weapons?	The nuclear weapons of North Korea issue.
task 7	What is the problem with theScreen Quarter System?	The Screen Quarter System issue because it has disappeared.
task 8	Overcoming the IMF problem	The IMF issue is taught in socials classes.
task 9	Netiquette	Netiquette education is required because a problem of netiquette was happening on the school homepage.
task 10	Family trip plan to Geojedo	There was a family trip planned to Geojedo around holiday on the 5th of the month.
task 11	Volcano	The nature of volcanoes is taught in science class.

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This study teaches seven steps for the PBL process in eleven tasks, and then analyses and observes the results to continually instruct insufficient parts of the Information Processing Abilities.

Step: 1 Provides a task related to life concerning time through website as shown in Table: 2. There are eleven tasks over eight months.

Step: 2 Each team creates a 'plan for task performance'.

Step: 3 Team members divide the task into personal tasks based on the 'plan for task performance'.

Step: 4 Students are taught how to collect the information that they need by themselves, how to write up sources to ensure reliability, and how to check for the information's validity in solving the problem.

Step: 5 Students are presented with personal tasks in active time and complete the team task through discussion. Students learn to remake the information that they found through classification, analysis, and comparison in order to solve the problem.

They then upload the result to the website and an analysis of their Information Processing Abilities is itemized. A steady improvement in the students Information Processing Abilities was observed.

Step: 6 Students listen to the various opinions of other teams at presentation time.

Step: 7 At the end of the team activity, the students make a reflection journal.

It is used as a good way for the students to reflect on their work, to check what they have learned, and what they think about their study.

RESEARCH RESULTS

This study applied PBL model to students in order to improve their Information Processing Abilities. It compared pre- and post-test to ascertain the difference of information processing abilities using'information processing abilities assessment table'.

This study assigned tasks to students and recommended their using an e-PBL board for learning.

It shows the efficacy of learning using an e-PBL board for research on actual conditions and provides an academic atmosphere for this study.

It shows the learning process of an authentically applied PBL model and verifies the effect on applying it by measurements before and afterward. Table 3 shows a comparison of the Information Processing Abilities of the students before and after applying PBL.

Table: 3
Comparison of information processing abilities based PBL before and after

Items	Assessment point of view	Pre-tests results N=23, %=100					Post-test results N=22, %=100				
		5	4	3	2	1	5	4	3	2	1
ICT Know-ledge	Do students remake the collected content as they want and edit using word processors and so on? (N)	4	8	2	0	9	12	6	3	1	0
	(%)	17	35	9	0	39	55	27	14	4	0
	▶ Do students insert photos and pictures properly to help with understanding? (N)	2	0	0	4	17	17	2	0	2	1
	(%)	9	0	0	17	74	77	9	0	9	4
	▶ Do students arrange the report using tables and charts that aid in easy understanding? (N)	0	0	0	0	23	15	3	1	2	1
	(%)	0	0	0	0	100	68	14	4	9	4
	▸ Do students upload document as attached files to the board of the class homepage? (N)	4	8	0	4	7	20	0	2	0	0
	(%)	17	35	0	17	31	91	0	9	0	0
Information Processing Abilities	▶ Do students find information and material which they need using the Internet? [Information collection] (N)	2	13	2	6	0	9	9	3	1	0
	(%)	9	56	9	26	0	41	41	14	4	0
	▸ Do students not select unnecessary information while searching the Internet, but only what they need? [Information selection] (N)	3	8	4	8	0	9	9	4	0	0
	(%)	13	35	17	35	0	41	41	18	0	0
	▸ Is the selected content information appropriate for the task? [Information reliability] (N)	2	13	8	0	0	9	9	2	2	0
	(%)	9	57	35	0	0	41	41	9	9	0
	▸ Do students write sources for the information collected? [Information reliability] (N)	1	2	0	4	16	15	1	3	2	1
	(%)	5	9	0	17	69	68	4	14	9	4
	▸ Do students do information classification, comparison, and analysis as they work? [Information classification, comparison, analysis] (N)	2	7	3	6	5	3	12	7	0	0
	(%)	9	30	13	26	22	14	55	27	4	0
	▸ Do students collect valid information for problem solving? [Information validity] (N)	1	13	6	3	0	2	14	6	0	0
	(%)	5	57	26	12	0	9	64	23	4	0
	▸ Do students synthesize and remake the information through classification, analysis, and comparison? [Information synthesis and remake] (N)	2	7	2	8	4	6	5	8	1	0
	(%)	9	30	9	35	17	27	23	36	4	0
	▶ Do students present their thoughts based on the collected information using valid statements? [Information internalization] (N)	1	1	0	3	18	2	12	5	2	1
	(%)	5	5	0	13	78	9	55	23	9	4
	▶ Do the results of the problem solving achieve the goal of authentic problem solving to some extent? [Information completion] (N)	1	7	5	7	3	8	10	4	0	0
	(%)	5	30	22	30	13	36	45	18	0	0

Scale - 5spoints:very good; 4 points: good; 3 points: normal;
2 points: needs instruction; 1point: needs much instruction

Research on the Actual Condition of Information Processing Ability Before Applying PBL
This consisted of a profile as in Table: 3 and an analysis of the actual condition of the Information Processing Abilities of the students. It itemized and analyzed the student subjects before applying the PBL. We, first, focused on their Information Processing Abilities before applying the PBL.

- ➢ About 40 percent of students used content from websites without editing. We therefore needed to teach the students about the editing process using a word processor to produce the content that they needed.
- ➢ Ninety-one percent of the students did not use materials such as photos, pictures, charts, graphs, and so on to help in understanding the content.
- ➢ Thirty percent of the students could not upload their report to the board of class homepage.
- ➢ In particular, 86 percent of the students did not indicate an interest in reliability; that is, what information was reliable or what was the basis of information that they collected. It was necessary to check for the reliability of the information and develop a proper attitude toward written sources considering the fact that there is an explosive increase in knowledge and a great deal of unreliable information.
- ➢ Ninety percent of the students could arrange information downloaded from the Internet; however, they were unable to express their opinions using the information, or use it as clues. They therefore needed to be instructed with respect to how to express opinions with the information found through a search of the Internet and how to use the information as clues.
- ➢ Sixty-five percent of the students knew how to select information from what they collected, but 35 percent of the students needed instruction.
- ➢ Forty-three percent of the students were not able to accomplish the PBL tasks because they were too unskilled to classify, compare, analyze, synthesize, or remake. There is an obvious need, therefore, for the students to have Information Processing Instruction with respect to classification, comparison, analysis, synthesis, and so on.

The results indicate the following for consideration.

- ➢ There are some students who cannot make tables and presentations to compare information through ICT abilities. In addition, some students cannot append files when they upload information to a site for sharing. ICT Literacy Training, therefore, should be taught to improve students' Information Processing Abilities.
- ➢ There are many students who simply copy the content of web page without any editing. It is necessary, therefore, to teach students the process of editing using a Word Processor.
- ➢ Many students produce a problem-solving report in a form that is difficult to understand. They need to be taught how to use photos, pictures, and tables to aid in understanding.
- ➢ Most of the submitted reports did not show the sources of the content which made them unreliable. Students need to be taught how to write content sources to ensure reliability and validity.

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Many students just copy and arrange the contents without classification, comparison, or analysis. They need to learn how to process information. Students need to be taught how to collect information, classify it, compare it, analyze it, and synthesize it. This is needed so that students can re-create information.

Comparing Information Processing Abilities before and after applying PBL

We analyzed the pre- and post-tests after the students had practiced with eleven tasks using the PBL process of seven steps based on the PBL model. We compared changes in their abilities using an itemized list from the 'Information Processing Abilities' of Table 3.

> ➢ Forty percent of the students used content without any editing from search engine. Afterward, over 95 percent of the students remade the information as they wished using a Word Processor and so on.
> ➢ Over 90 percent of the students did not insert photos, pictures, tables, graphs, and so on which could have helped in the understanding of the content of the report. Afterward, over 86 percent of students inserted photos, pictures, tables, graphs, and so on to support their reports.
> ➢ Thirty percent of students couldn't upload attached file to the board of the classroom homepage. After applying PBL based on Web, all of them could do that.
> ➢ Fifty-two percent of the students used information that had been classified, analyzed, and compared. Afterward, 96 percent of the students could use information with these methodologies in the post-test.
> ➢ In pre-test, 14 percent of the students were interested in reliability; they checked to see if their information was reliable and what the source of information was. Afterward, 86 percent of the students provided the source of their information to check its reliability.
> ➢ With respect to the internalization of the information, only 10 percent of the students used searched information as clues. Afterward, in post-test, 87 percent of the students could use information as clues to support their thoughts after their classification, analysis, comparison.
> ➢ Forty-eight percent of students knew how to select information that they needed and 35 percent of the students used the information without any selection. Afterward, however, 82 percent of the students were able to select information properly. There were no students who simply provided information without any selection process.
> ➢ At the beginning, 35 percent of the students succeeded in completely solving the problem through selection, classification, analysis, comparison, synthesis and re-production. Afterward, 81 percent of the students' completed the task very well.

CONCLUSION

This research used a PBL model to improve the information processing abilities of a group of elementary students. Let us look at the results of the pre-test in an analysis of the information processing abilities of the students before applying PBL model. First, About 40 percent of the students used content from websites without editing.

Second, 91 percent of the students did not use any materials such as photos, pictures, charts, graphs, and so on to help in the understanding of their reports.

Third, 30 percent of the students could not upload their report as an attached file to the board of the class homepage.

Fourth, over 75 percent of the students were accustomed to collecting information, but did not have sufficient ability to classify, compare, and analyze the collected information. Fifth, and not significantly, 86 percent of the students had no interest in the reliability of their sources or what was the basis of the information that they had collected. Sixth, 90 percent of the students could arrange information from Internet, but they were unable to express their opinions using the information as support. Seventh, 65 percent of the students knew how to select information that they wanted to collect, but 35 percent of the students needed instruction. Eighth, 43 percent of students were not able to complete the PBL tasks because they were unable to classify, compare, analyze, synthesize, and remake.

Now, let us examine the changes in the information processing abilities of the students from the pre-test to the post test and the application of the PBL model. First, over 90 percent of the students did not insert photos, pictures, tables, or graphs to help in the understanding of their report. Afterward, over 86 percent of the students inserted graphic materials to support their report. Second, 30 percent of the students could not upload an attached file to the board of the classroom homepage. After applying PBL based on the Web, all of them were able to do this. Third, 52 percent of the students used information which had been classified, analyzed, and compared. Afterward, in the post-test, 96 percent of the students could use information with these methods. Fourth, in the pre-test, only 14 percent of the students were interested in reliability of their information or what the source of their information was. Afterward, 86 percent of students provided the source of their information to check its reliability. Fifth, with respect to the internalization of the information, only 10 percent of the students could use their research information to support their opinions. Afterward, 87 percent of students could use their information to support their thoughts after classification, analysis, comparison in the post-test. Sixth, 48 percent of the students knew how to select information that they needed and 35 percent of the students use the information without any selection. Afterward, however 82 percent of the students were able to use the selected information properly. There were no longer any students who used information without any selection. Seventh, at the beginning, only 35 percent of the students succeeded in completely solving the problem using selection, classification, analysis, comparison, synthesis, and re-production. Afterward, 81 percent of the students completed the task very well.

These are the results of this study. First, there were very significant improvements in the students' abilities. The percentage of 'information selection' abilities increased from 48 percent to 82 percent. 'Checking of information reliability' increased from 14 percent to 86 percent. 'Information classification, analysis, and comparison' and 'internalization of information' abilities increased from 52 percent to 96 percent.

The abilities involved in 'information collecting' and 'checking for information validity' increased only slightly from 88 percent to 96 percent, and from 74 percent to 96 percent, respectively; probably because the learners had these skills to some degree before the PBL model was applied. Second, the number of students who inserted photos, pictures, tables, and graphs in their reports to help in its understanding increased from 9 percent to 86 percent.

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Forty percent of students used content from websites without any editing; but, after the application of the PBL model, over 95 percent of the students remade the information as they wanted using a Word Processor of some kind.

Third, their information processing abilities improved because this was not cramming method of teaching; but, instead, the process of solving a problem and making a 'task plan' based PBL. It is a teaching-learning method that improves information processing abilities. There are some implications from this study. First, it is helpful to apply the PBL model to improve information processing abilities; therefore, program research and development to improve information processing abilities using various teaching-learning models (Goal Base Scenarios, Action Learning, etc.) based on learning by doing in addition to PBL should be continued. Second, ICT literacy training should precede PBL work if information processing abilities is to improve. The '2009 Revised Curriculum' being applied in Korea at this time does not allow enough time for ICT literacy training. Each school, therefore, should provide ICT literacy training time as part of the national curriculum in order to improve the students' information processing abilities and make them suitable for the information age.

Authors' Note: Correspondence concerning this article should be addressed to Dr. Jaemu Lee, Department of Computer Education, Busan National University of Education, Busan, South Korea, 611-736. Phone: 82-51-500-7322. Fax: 82-51-500-7321. E-mail: jmlee@bnue.ac.kr

BIODATA AND CONTACT ADDRESSES OF THE AUTHORS

Du Gyu KIM (1971 11 05) is a visiting professor at University of North Texas. He has been an elementary school teacher since September of 1997 in Korea. He obtained his PhD in educational technology from Pusan National University in 2010 in Korea. He was a post-doctorate researcher at the Institute of Education Development at Pusan National University in Korea from March 2011 to February 2012. His research interests include intelligent tutoring systems, adaptive learning systems, u-learning, and educational technology.

Du Gyu KIM
Dept. of Learning Technology, University of North Texas
3940 N. Elm St., Suite G150, Denton, TX 70607, U.S.A
Tel: +1-469-544-9026
Fax: +1-940-565-4194
Email: kdugy@hanmail.net

JaeMu LEE (Born in 1960/07/18) has been a professor in the Computer Education Department at the Busan National University of Education in Korea since 1987. He obtained his PhD in computer science from the Hongik University at 1994 in Korea. He was vice president of the Korea Information Education Association from March of 2005 to February of 2007. He has been a visiting scholar at Syracuse University, Florida State University, and Korean Education Research Information Services. His research interests include intelligent tutoring systems, adaptive learning systems, educational ontology, and instruction methods for the computer.

JaeMu LEE
Dept. of Computer Education, Busan National University of Education
24 Gyodaero, Yeonjegu, Busan 611736, REPUBLIC OF KOREA
Tel: +82-10-8332-2221
Fax: +82-51-486-8868
Email: jmlee@bnue.ac.kr

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