Developing a Video-based Smart Mastery Learning through Adaptive Evaluation

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Abstract

This paper proposes to develop a novel e-learning model based on dynamic formative evaluation. In case of the evaluation of the existing e-learning, repetitive learning to achieve mastery, causes learners to degrade immersion and become neglectful of learning. The dynamic formative evaluation proposed is able to supplement the limitations of the existing approaches. Since a repetitive learning method does not provide perfect feedback, this paper puts an emphasis on dynamic formative evaluation that is able to maximize learning achievement. Through the dynamic formative evaluation, the instructor is able to refer to the evaluation result when making an assessment about the learner. For our model that shows the flow chart of learning, based on dynamic formative evaluation, we prove its effectiveness and validity by implementing our model and analyzing it.

Keywords: *Online Learning, Dynamic Formative Evaluation, Mastery Learning, Repetitive Learning Method, Learning Achievement*

1. Introduction

Conducting an online class is difficult due to the lack of communication and interaction between the instructor and the student. An instructor cannot verify the learning behaviors of the students, thus, they must merely give a grade based on attendance, and assessments. Some students abuse this privilege by sharing answers with other students [1, 2]. However, the biggest problem is that e-learning systems cannot provide 'whole learning' to students who have a strong willingness to study [3].

Any educational method must offer high quality interaction elements to learners to provide interest and voluntary active participation in learning [4, 5]. However, in the existing studies on evaluation, there is a limitation to formative evaluations due to the fact that they are always restricted to four or five-choice question forms. When a learner reviews, he/she solves the question and example one more time. In this case, a learner already knows the answer. It means that the learner can choose the correct answer without understanding the full concept [6].

For the instructors or producers of online lectures, it is not easy to prepare diverse formative evaluation in advance. It can also be inefficient in the aspects of using data space to save the materials [7]. However, it will be a problem if students solve the same questions that refer to the original online lectures without understanding the learning contests. This means that it is difficult to check the progress of the learners, since there is no way to measure whether they are following the course or just guessing the answers.

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Online learning based on the dynamic formative evaluation solves this problem. If an instructor inputs the content of question according to the suggested form, there will be various kinds of questions based on the original question. Changing of the questions demands the complete understanding of a learner. It raises their learning achievement [8]. In addition, it helps students to retain tension while learning, and prevents them from feeling bored during a class without any mutual interaction. It is also efficient because the instructor do not have to labor by creating each new question. In addition, the method of inputting questions is an efficient method to the store data.

2. Related Work

Soon-hee Im uses a dynamic formative evaluation algorithm that could allow the students to achieve mastery learning by changing the examples of questions dynamically [6]. The purpose is different from our paper in that it emphasizes playfulness and causes interest by using edutainment to raise learning achievement through e-learning. Mi-hye Kim suggests that various teaching-learning methods must be presented to trigger intrinsic learning motivation in online learning [9]. Making an emphasis on content type rather than evaluation is different from the focus of this paper. Tae-young Im proposed a method that can create an item including multimedia in online learning using the items stored in database [10]. This method couldn't provide the item that could be changed randomly. Mi-sun Shin asserted that most of static evaluations could be lower the interest of learning in the existing online learning similar to our viewpoint and proposed a scheme that could provide a detailed item classified into grade, semester, section, *etc.,* [11].

In recent online learning, as a variety of smart appliances are used, it is important for instructors or learners to use properly those [12]. There are some problems in the existing types of online learning. For example, the formative evaluation questions are always the same because there is a restriction in the number of questions. Therefore the learner who already knows the answer feels less pressure about problem solving and it leads to tension loss during class hours. It causes the learner to pay less-attention to the class.

The online learning system targets many random learners. It enables the learners to get rapid feedback and to easily moderate the question's level of difficulty, reliability, validity and discrimination. Further it can analyze the result for evaluation rapidly.

There are both objective and subjective evaluation forms. An objective test type is composed of multiple-choice, true-false, matching type, and so on. A subjective type is composed of short answer type, essay-type, completion type, and so on [13]. To receive a more accurate evaluation of the progress, multiple choice questions are more consistent than short answer questions [14, 15]. The former exclude extrinsic factors that can affect fairness or objectivity of the assessment. And it is useful because of its reusability. Additionally, a wider variety of objective problems are needed in order to obviate defects of existing formative evaluation in online learning.

There is an adaptive learning approach in the field of information security education [16]. The paper proposed an adaptive approach using a situation-setting related to information security education. Our study is based on the previous research related to online mastery learning [17].

3. Design

3.1. Flow Chart of Dynamic Formative Evaluation

'Unit' means a part of learning animation which includes contents of each formative evaluation question. In adaptive formative evaluation model, after watching a learning animation of Unit 1, a learner solves the questions using formative evaluation. If a learner understands completely, he/she will pass Unit 1. Online learning, based on the dynamic formative evaluation model, shows a pertinent unit video again, or asks the learner to solve a new question in the case of choosing a wrong answer. In addition, it will allow the learner to choose to be provided with a pertinent unit video again, or asks to solve a new question in case he/she did not fully understand.
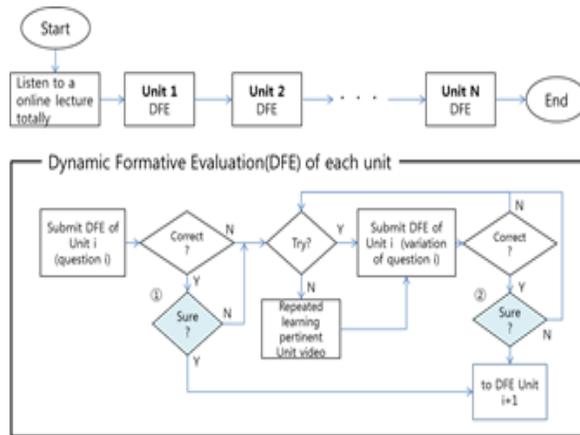
Figure 1. Flow Chart of Dynamic Formative Evaluation

The flow char includes two meanings of 'sure' for checking degree of understanding in learning,

· Sure ① is the step for checking whether to solve question based on understanding or not.

· Sure ② is the step for checking whether the mastery understanding about the pertinent Unit has been reached even though the learner chose the correct answers to the questions.

3.2. Requirement Analysis
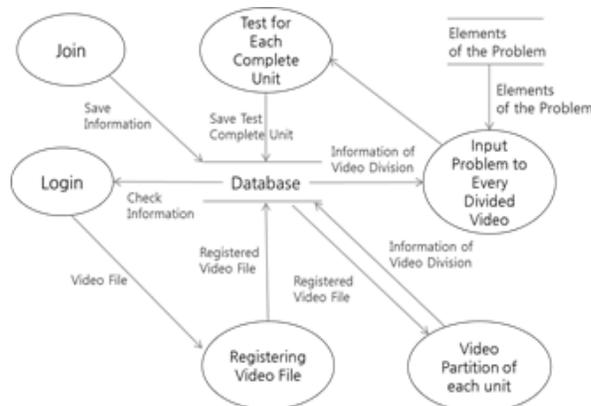
Figure 2. Data Flow Diagram

3.3. Dynamic Formative Evaluation Algorithm

Suppose user inputs a main concept (A~C) and explanations (a1, a2, …, c2, c3) about A, B, C concerning the pertinent Unit to build a dynamic formative evaluation question. There are three types of question which are built through the dynamic formative evaluation model.
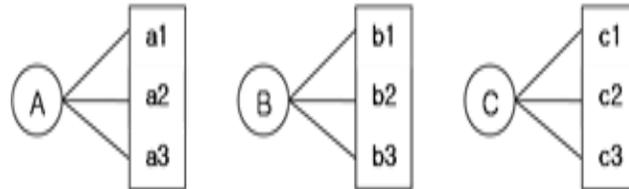

Figure 3. Main Concept and Explanations of Question

3.3.1 Best Answer Type: This method is choosing the correcting answer about ( ). ( ) invokes the dynamic formative evaluation model because one of the main concepts (A, B, C) is able to input ( ). Figure 3 and Figure 4 show algorithms that dynamically change examples of the question in case of question A or B.
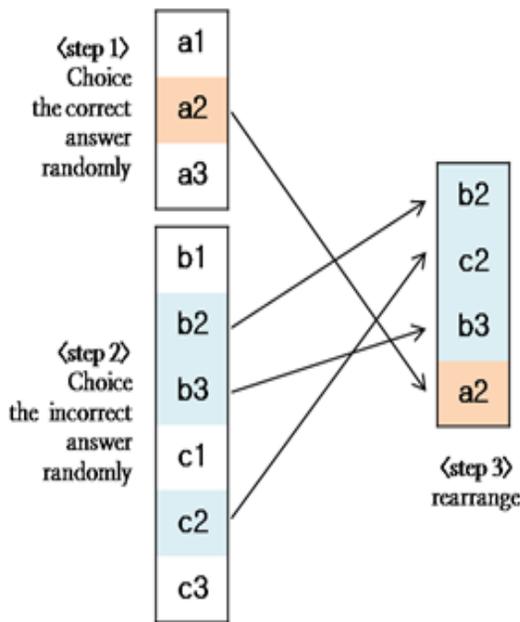
Figure 4. Creating Examples of Question A
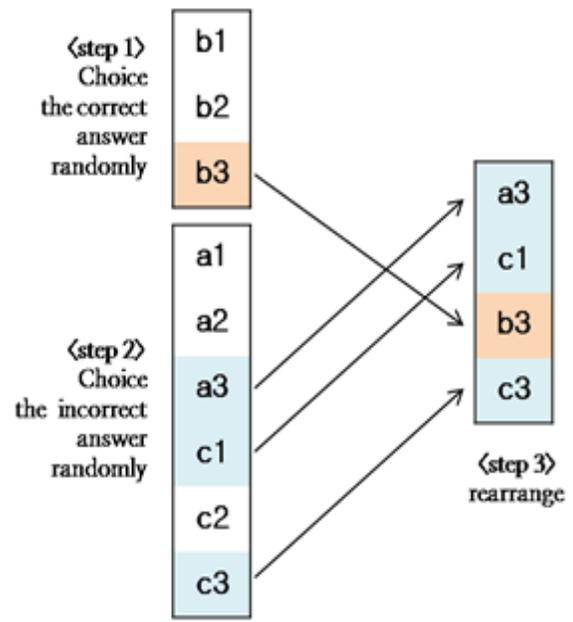
Figure 5. Creating Examples of Question B

3.3.2 Multiple-answer Type: This method refers to choosing all the correct answers denoting a ( ). It means that there are two or three answers because a user inputs only three explanations. Figure 5 and Figure 6 show the algorithms of multiple-answer type.
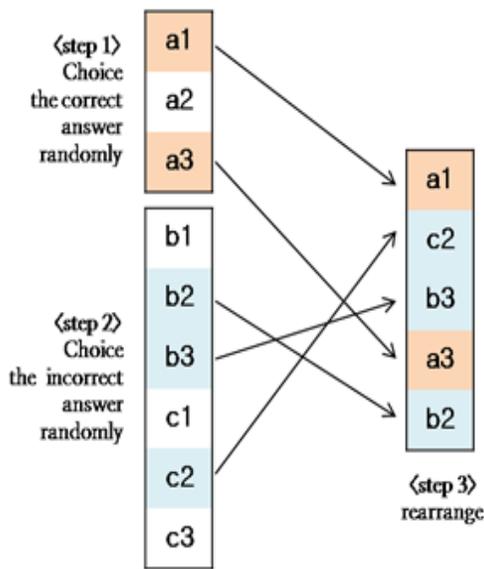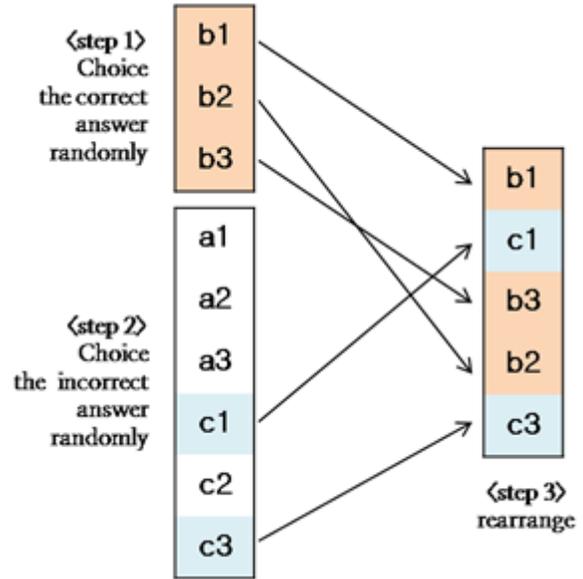
Figure 6. Creating Examples: 2 Answers

Figure 7. Creating Examples: 3 Answers

3.3.3. Matching Type: This method is to find out the closely related pairs of elements. In step 1 and step 2, the examples, which are chosen in each group of examples that represents a main concept, are rearranged. These rearranged examples will be matched to the main concepts, which are arranged randomly.
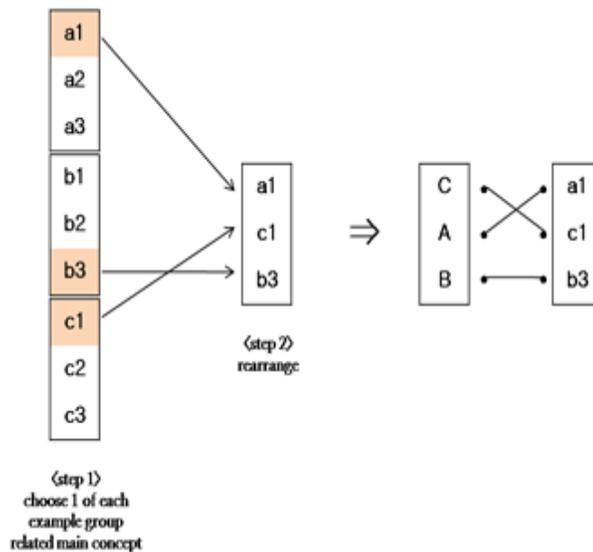

Figure 8. Creating Examples of Matching Type

4. Implementation

Programming languages like HTML, PHP, and JavaScript are required to develop an e-learning authoring tool based on the web and to set the starting time in video file for replaying

parts of the video. MySQL is used to register a user account and save the dynamic formative evaluation in a database system.

There are pages for the developer and pages for learner. When the developer logs in with the created account, he or she can register the learning video. The developer then inputs the starting point and ending point where the formative evaluation problem will be to divide the video. This partial video is called 'unit' in this research. This unit is for the learner to learn the part needed after solving the formative evaluation problem. When reviewing, it only plays the part that the developer has input.

As a next step, the developer inputs the formative evaluation problems according to the unit context. First, the developer inputs the main concept and then inputs the definitions. This input is saved in the database. When the learner is solving the problem, the database identifies the video name and unit number to bring the corresponding data. Every time the learner solves the problem, in outputs the data into short-answer type, multiple-answer type, or mixed answer type.

4.1. Result of Developer Page Display

4.1.1. Start Page: As Figure 9, one can log in at the start page and clicking 'Join' button leads to the join page.
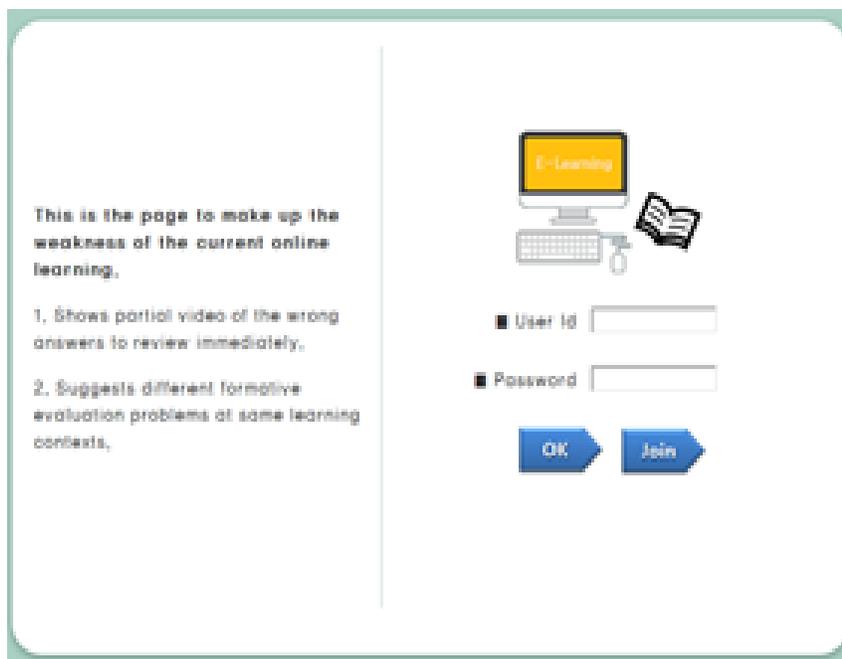

Figure 9. Start Page

4.1.2. Registering Lecture: The developer can register a video as following. After registering the lecture file, when you divide the video and complete the input of the problems you can confirm the registered file as the Figure 11. If you click the 'edit' button, you can modify the detail information of the video.
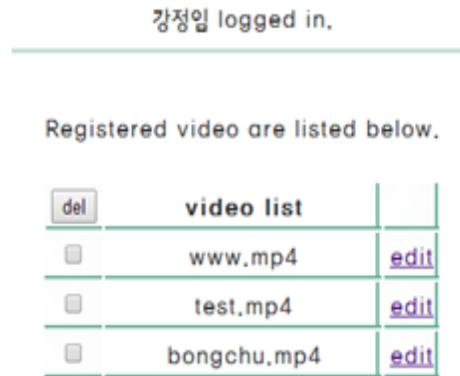
Figure 10. Registering Lecture

Figure 11. Video List

4.1.3. Video Partition of Each Unit: Several units can be made inputting the start and end point of the registered video. The word 'unit' refers to the part that the maker will provide in the learning video. If the learner wants to review after solving the formative evaluation problem, he can play the partition of the unit video.
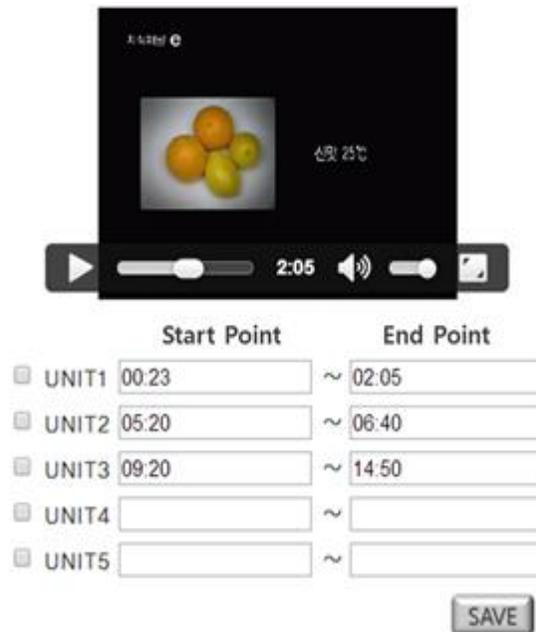

Figure 12. Video Partition of Each Unit

4.1.4. Inputting Elements of the Problem: Radio buttons are created according to the number of the unit that the maker inputted on the video partition page. Click the corresponding unit button and input concepts and explanations for it, then, save. The example is as following. If the contents are inputted, they are saved in order at the bottom table as the figure below.

UNIT	Concept	Explain1	Explain2	Explain3	Explain4	Explain5
1	smishing	new hacking b:	If the phone u:	A compound	Malicious cod:	Recently smis
1	Trapdoor	A secret pathv	Also called 'ba	A gateway tha	In order to mo:	A security hol
1	Pharming	A method of a:	It falsifies the	In order to pre	Also needed t	The domain na
2	Specialist for	Establish sec:	If an invader is	If one that is n	Use firewall, a	Be informed of

Figure 13. Inputting Elements of the Problem Example

4.2. Result of Learner Page Display

4.2.1. Start Page: In the first part of the learner's page, the learning video list that the producer registered appears.

Figure 14. Start Page

4.2.2. Learning: If the user clicks the video that he wants, the videos are played. If he clicks 'start solving' button, it starts with unit 1 until the number of units that the producer registered.

Figure 15. Learning Page Example

4.2.3. Solving a Formative Evaluation Problem: If the learner presses the 'start solving' button, one problem will be selected out of many types of problems. Also problems are made randomly as the producer inputted, suitable to the type. There are types like best answer type, multiple-answers type, matching type as the figure below.

Figure 16. Solving Formative Evaluation Problem Example

4.2.4. After Solving Formative Evaluation Problems: If the learner had not solved the problem, he can click 'play relevant video' button in order to review or solve another transformed problem. Also if he had solved the problem, he can solve another problem or watch the relevant video. 'Go to the next unit' button is recommended if the learner had totally comprehended of the corresponding video of the unit.

Figure 17. After Solving Formative Evaluation Problem Example

4.2.5. Review Relevant Video: relevant video is differed as the starting point and the end point that the maker had inputted. If the learner clicks the start button, the video will be played from the starting point. The learner who had watched the video enough, can click 'solve another problem' in order to check his level of his learning.

Figure 18. Review Relevant Video

5. Analyzing the Questionnaire Result

We made a questionnaire to 47 students, 26 students of the college of education, 14 students of the college of non-education and 7 high school students. When we classified them into sex or grades, we could not find anything specific, but when we classified them into college of education students and college of non-education students we found the following.

▪ Do you think it is effective to solve the same question repeatedly?
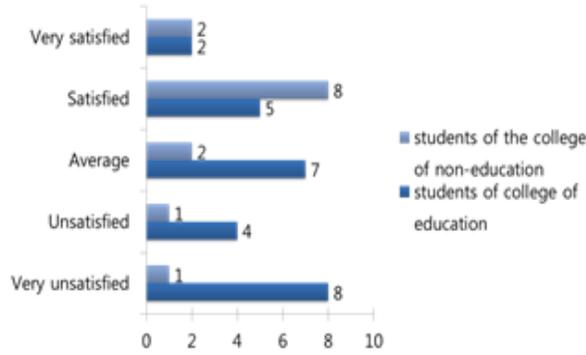

Figure 19. Questionnaire Result 1

▪ Do you think it is helpful for learning when formative questions are different every time?
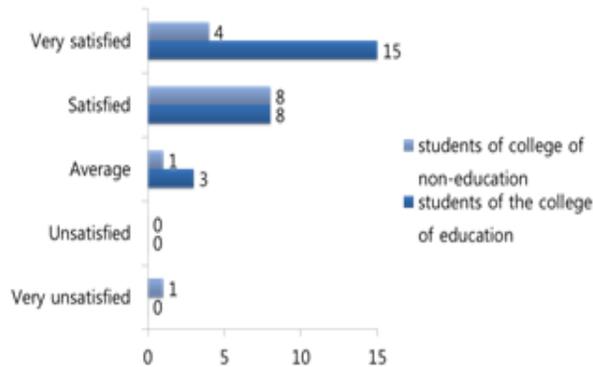

Figure 20. Questionnaire Result 2

If we classify them into education and non-education major students, we can find the following. Contrary to the non-education major students, education major students corresponded that 'providing same problems all the time' would be ineffective. That is to say, 'providing different problems each time' is satisfied highly to the education majored students. The education major students would have more effective teaching technique than the non-education major students. In this regard, the effectiveness of on-line learning page of our study would be expected to have great results.

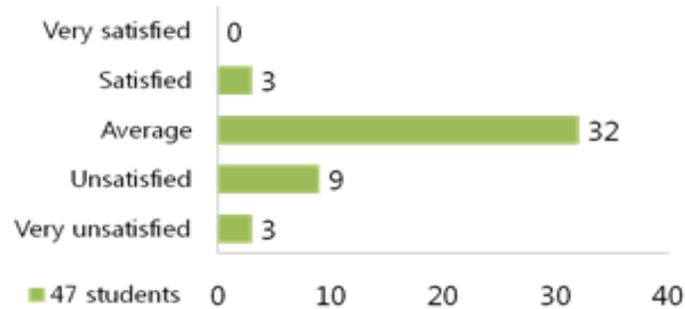▪ How much are you satisfied with the existing on-line learning methods?

Figure 21. Questionnaire Result 3

▪ If this on-line learning method is complemented and then commercialized, would you be interested in using this program?
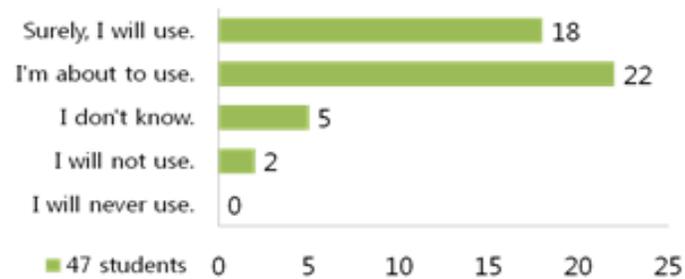

Figure 22. Questionnaire Result 4

Analyzing the results totally, 40 students out of 47(85%) corresponded that they would use the on-line learning program that our study had made. Considering these results, the dynamic formative evaluation method that is our principal function of this study would be sued as a considerably effective method of learning in the on-line learning area.

6. Conclusion

This study suggests an analysis of situations that can occur during online learning that applies the dynamic formative evaluation. The dynamic formative evaluation model supplements the limitations on existing types of online learning, which cannot increase learning achievements.

However, there is a problem that had not been solved in our study. The problem is that the learner can infer the answer of the next problem from the previous problems and answers. The hint comes from that since the answer was chosen on the previous problem, it would not be answer of the next problem. This can be solved when inputting sources of the problem. Not only can the information of the correct answer be input but also the information of the incorrect answer. The incorrect answers of the corresponding concept are not used at other problems, so the answer of the different problem is not exposed. But this solution plan

involves the inconvenience of the maker that he has to input a lot of things. Therefore, to find a solution that is close to the perfect, we need to research more based on the suggestion above.

It will be less complicated for instructors who are inexperienced with computers to produce an online learning course with an e-learning production tool which is based on the dynamic formative evaluation model. With more consistent use of this tool by the instructors, numerous limitations of the original online learning system will be complemented effectively.

Acknowledgements

References

[1] N. Rowe, "Cheating in online student assessment beyond plagiarism", Online Journal of Distance Learning Administration, vol. 7, no. 2, (2004).

[2] K. Kim, "A study on analysis and improvement methodology of the learning evaluation system for the on-line education", Master's thesis, Seowon University, (2004).

[3] D. Lee, "A study on the improvement of online education model", Master's thesis, Inha University, (2014).

[4] N. Friesland, "Formative assessment in instruction as perceived by teachers", University of Kansas, (2010).

[5] M. Robles and S. Braathen, "Online assessment techniques", The Delta Pi Epsilon Journal, vol. 44, no. 1, (2002).

[6] S. Im, "A design and implementation of edutainment contents for learning the operation principles a computer", Master's thesis, Jeju National University, (2011).

[7] S. Park, "The design and implementation of a drill-and-practice type online formative evaluation system based on academic achievement analysis", Master's thesis, Korean National University of Education, (2012).

[8] J. Ha, "Design and implementation of web-based formative evaluation system", Master's thesis, Kyungnam University, (2007).

[9] M. Kim, "Web-based e-learning system supporting an effective self-directed learning environment", The Korea Contents Association Journal, vol. 11, no. 9, (2011), pp. 524-535.

[10] T.-Y. Lim, "The design and implementation of a web based on-line learning evaluation system using database", Master's thesis, Kumoh National Institute of Technology, (2005).

[11] M. Shin, "Online education evaluation system using dynamic question generation method", Master's thesis, Dongguk University, (2005).

[12] M. Kim, "Study on effectiveness of e-learning – focus on simulation", Master's thesis, Kwangwoon University, (2011).

[13] H.-S. Park, "Design and implementation of on-line formative evaluation supporting system using e-learning environment", Master's thesis, Chosun University, (2006).

[14] H. Kim, "Testing effect in a new computerized modified multiple testing system", Master's thesis, Sejong University, (2003).

[15] M. Park, "Effective achievement of teaching objectives through realization of on-line formative evaluation education system", Master's thesis, Pusan University of Foreign Studies, (2004).

[16] Y. Ko, S. Lee and S. B. Kim, "Development and Analysis of an Information Security Learning Method using Situation-based Problems", International Journal of Security and Its Applications, vol. 7, no. 5, (2013).

[17] J. Kang, M. H. Kim and S. B. Kim, "An Online Mastery Learning Method Based on a Dynamic Formative Evaluation", World Academy of Science, Engineering and Technology, International Science Index, vol. 86, (2014).

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