Wong, L.-H. et al. (Eds.) (2013). Proceedings of the 21st International Conference on Computers in Education. Indonesia: Asia-Pacific Society for Computers in Education

Analyzing Online Quiz Responses to Support One-to-One Instruction in the Classroom

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Abstract: In this paper, we propose a method to detect failure of learning to support one-to-one instruction in the classroom, using quiz responses in Moodle, a course management system. Failure of learning is defined as a situation in which the correct answer rate of a particular learning topic in a quiz is significantly lower than the correct answer rate of other topics answered by students in the same quiz. In this study, the researchers identified the presence or absence of failure of learning in actual classes to evaluate the usefulness of the proposed method. The results revealed that more instruction was given to the experimental group.

Keywords: Course Management System, Failure of Learning Detection, Learning Analytics

1. Introduction

Course management systems are able to accumulate a vast amount of information; this accumulated collection of education data is extremely valuable for analyzing students' behavior. Data mining in course management systems is the automatic extraction of implicit and interesting patterns from the historical data on learning activities, for example, lessons, forums, and quizzes (Klosgen and Zytkow, 2002). Through data mining of a set of quiz responses, we are able to detect failure of learning (a situation in which students attempt to solve problems but, in encountering unexpected difficulties, are unable to progress smoothly (McCartney, Eckerdal, et al., 2007)). In course management systems, some topics of interest regarding failure of learning are as follows: how to determine failure of learning in real time, and how to present failure of learning information to teachers and students.

Providing one-to-one instruction for students with special needs can be very effective for learning in the classroom (Friend and Bursuck, 2006). Failure of learning, to enable one-to-one instruction by providing teachers the learning contents of the lack of understanding.

The purpose of this paper is to propose a method to detect failure of learning in students using their quiz responses in Moodle, a course management system (Moodle, 2012). The proposed method is to use a data analysis strategy (Dale and Vitalija, 2003) to identify students exhibiting failure of learning, and to provide one-to-one instruction as well as instruction for the entire class. In this paper, we identify failure of learning as an event where the correct answer rate for a particular item is significantly lower than the overall correct answer rate for other items on the quiz. The significance of this research is that it can grasp the students in lack of understanding by detecting the failure of the learning.

2. Determining Failure of Learning

The purpose of determining failure of learning is to identify learning challenges in both the entire class and in individuals. To determine unsuccessful learning, we identify questions on the Moodle quiz that correspond to each learning unit and to each learning topic. It is necessary to enter the names of learning units and learning topics and to map them for each question in advance; data mining techniques are then applied to the quiz responses. A chi-square test of independence of statistical methods is employed to determine the failure of learning.

The failure of learning of the entire class is derived from a comparison of the correct answer rate in the classifications of items, such as learning, and a significantly lower unit. A chi-squared test of independence is employed to determine the rate of failure of learning. With this test, we assess whether the values of row and column items are independent (Bull and Rastin, 1992). The algorithm of determination for the class is as follows:

1. The teacher enters the learning unit, learning topic, or question as an item, as well as the significance level.
2. The responses of participants to the quiz questions corresponding to the entered items and their parent classification items are obtained from Moodle.
3. The rate of correct answers for each item is calculated.
4. If the correct answer rate of an item is lower than the correct answer rate of its parent classification, a chi-squared value is calculated from that item's correct/incorrect answer rate and its parent classification's correct/incorrect answer rate. The degree of freedom in the test is 1.
5. If the null hypothesis is rejected, the item is outputted from the chi-squared value and the significance level.

3. Presenting Failure of Learning

After determining the presence of failure of learning through the algorithms mentioned in Section 2, we present the information in visual to teachers and students (Figures 1 and 2).

On the "Quiz Responses" page (Figure 1), the correct answer rates for learning topics for which students demonstrate failure of learning are displayed in red. This method of presentation is discussed previously with the students during class time. Then, a list of students who gave incorrect answers is displayed. In this list, the student IDs of those who have exhibited failure of learning are shown in red (Figure 2).

Learning items	Question number	Correct answer	
Repetition (while)	Question 3.3-1	87.0 %	69.6 %
	Question 3.3-2	71.7 %	
	Question 3.3-3	50.0 %	

Figure 1. Quiz responses of the entire class.

Students with incorrect ans. Learning Unit: Method 28 / examinees 46

When you click the student ID, we will show the quiz results for individual students.
The color red of student IDs represents the students who have failure of learning for any item.

Student ID	Full name	Seat Number	Correct answer
1115xx1	Tarou Nikkou	-	0.0 %
1115xx2	Jirou Nikkou	-	0.0 %
1115xx3	Saburou Nikkou	-	27.8 %

Figure 2. A list of students who gave incorrect answer.

4. Evaluation

The objective of evaluating the system is to assess the usefulness of failure of learning detection to support teachers' instruction and students' learning. We developed the following two hypotheses regarding the usefulness of the proposed method:

(1) Students who exhibit failure of learning receive extra instruction from teachers.
(2) There is a difference in the amount of time students devote to reviewing quiz responses.

Hypothesis 1 can be confirmed from the instruction log, where the teacher records how much times/he spends with students. Hypothesis 2 can be substantiated using the difference time students review the quiz items.

The course, which lasted for two hours each time and went on for six weeks, was entitled "Basic Programming Exercises" and consisted of three phases: lecture, quiz, and exercise. A five-minute quiz was given at the end of each lecture. An evaluation experiment was carried out with the teacher of two classes using the same learning content; students were randomly assigned to one of the two groups. In one class (the experimental group), the teacher and students were presented with the information on their failure of learning, while in the other (the control group), this information was not presented. The student ID numbers of the experimental group are shown in red and that of the control group in blue (Figure 2). Hypothesis of difference are compared to the corresponding percentage of the number that is different from the number of experimental and control groups. Teachers and students did not know who was in either group.

The experimental group received 57 instruction sessions (25.0%) and the control group received 34 (13.9%) that of the number of teachers (Table 1). The experimental group was the most statistically significant at 5%. In the experimental group, the quiz responses were viewed by students 89 times (71.9%), whereas in the control group, responses were viewed by students 64 times (49.8%) (Table 2). The experimental group is statistically significant at 5% level of significance.

Table 1: Number of instruction sessions for students with failure of learning.

Type of instruction	Experimental group	Control group
Class	11	0
Individual	46	34
Total	57	34

Table 2: Number of times quiz responses were viewed by students.

Experimental group			Control group		
Examinees	Number of views	View rate	Examinees	Number of views	View rate
89	164	71.9	64	122	49.8

5. Conclusion

In this paper, we proposed a method to detect failure of learning in one-to-one classroom instruction using the quiz responses in Moodle, a course management system. This method defines failure of learning as occurrences in which the correct answer rate of a learning topic in quiz responses is significantly lower than the correct answer rate of other learning topics. We then evaluated the usefulness of this method in actual classes. The experiment revealed that a significantly large number of students checked their failure of learning status. Additionally, there was also a difference in the amount of instruction given to students: students in the experimental group received more instruction. From these results, it can be concluded that detecting and presenting failure of learning using the proposed algorithm is useful for teachers' instruction and for students' review and learning.

Future work is that it is related to learning content in the teaching of the past and thus to analyze the learning content which is a factor of failure of learning contents.

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