Chang, M. et al. (Eds.) (2019). Proceedings of the 27th International Conference on Computers in Education. Taiwan: Asia-Pacific Society for Computers in Education

A System for Finding and Improving the Relevant Contents of Digital Textbooks based on Quizzes' Contents

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Abstract: In this paper, we developed a digital textbook content improvement system, which can help teachers to find and improve the relevant content of digital textbook objectively based on the contents of quizzes. Based on the DITeL system, we have designed two modules of the system configuration. The first part includes the functions such as registration, modifications and deletions of the contents of questions, optional items and students' answers, and the calculation and display of average grades ratio about questions which have been answered by students. The second part is based on the question and the correct answer, automatically to search relevant page about the digital textbook. We aim to use the system that students can take quizzes in every lesson to test the level of mastery of their knowledge. And teachers can find which questions that students got lower scores, and which the contents of relevant page about the digital textbook need to be improved.

Keywords: digital textbooks, quizzes, educational data mining, system configuration

1. Introduction

In recent years, with the development of e-publishing technologies for communications and learning, many educational institutions have been investigating and implementing e-learning systems. So more and more traditional textbooks have been replaced by digital ones (Rainie, et al., 2012, Yin et al., 2014). By 2020, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is scheduled to change all the traditional textbooks for elementary, middle, and high schools into digital textbooks in Japan (Yin et al., 2015).

In the past decades, various studies have been conducted to investigate the effectiveness of learning with digital textbooks (Hezroni, 2004; Reinking, 1997; Snyder, 2002; Yin et al., 2017). In previous studies, a digital textbook system has been developed to collect textbook reading data such as "turning to next/previous page", "memo", "zoom in/out", "adding marker". The system is named as digital textbook for improving teaching and learning (DITeL). Teachers and students can use the system and read the digital textbook by using mobile devices such as iPad, iPhone, and Android (Yin et al., 2017, Yin & Yamada et al., 2018).

It is very convenient to use digital textbooks to learn by using mobile devices (Yin et al., 2010). However, many of these digital textbooks were created based on the authors' experience in a subjective manner. Therefore, the problem is how the contents of digital textbooks can be evaluated and improved (Yin & Hwang et al., 2018). Digital textbooks have become a potentially effective pedagogic tool for supporting teaching, learning and scholarship. Therefore, how to measure the quality of digital textbooks, and how to evaluate and improve the content of digital textbooks become very important issues (Yin et al., 2016).

In this paper, based on the DITeL system, we developed a new system, which can help teachers to improve their teaching contents in a much more objective manner based on the students' test scores, and the relevant contents to the questions which can be searched automatically. We named the system as DITeL2. According to the modules of the system configuration, we have designed two parts. The first part is the registration, modifications and deletions of the contents of questions,

optional items and students' answers. And the calculation and display of average grades ratio about questions which have been answered by students. The second part is automatic search for the relevant pages of the digital textbook based on the questions and the correct answers.
The students can take quizzes in every lesson to grasp their comprehension level by using our system. And teachers can grasp which parts of their teaching materials were difficult for their students by their test scores. If the average score of a question is very low, through the data mining technology, the DITeL2 can find the relevant learning contents from the digital textbooks, and feedback the learning contents to the teachers. The teachers can review whether the relevant learning content of the digital textbooks needs improvement. If they consider that the relevant learning contents were not explained well, then the teachers can improve the contents themselves.

2. Literature Review

Data analysis is an internal step in the process of data collection (Yin, Hirokawa, et al., 2013; Yin, Sung, et al., 2013). Our system collects data automatically while the learner is using the system.

2.1 Previous Studies of Data Collection Research on Digital textbooks

There have been some studies on distribution systems of digital learning materials where questionnaire surveys were conducted on their usability (Siegenthaler et al., 2010). There are also some researches conducted which examined the efficacy of digital textbooks compared with traditional paper-based textbooks in terms of the improvement of their reading skills, reading comprehensions, and reading strategies (Daniel et al, 2013; Anton et al., 2013; Nelson & O'Neil, 2001) as well as some researches on technological literacy concerning reading and writing skills (Ihmeideh et al, 2014).
There have been very few researches conducted so far to improve digital textbook by using massive learning data (Yin et al., 2016). Although, there are a few researches were conducted to improve digital textbook by using learning data. For example, Bakia and Güvelib (2008) proposed to improve a web-based mathematics teaching materials by collecting data such as attitude scale, interviews, field observations. But, the sample data is very small. And these qualitative and quantitative data were collected from the sample, consisting of eighteen teachers and eighty students.

2.2 Previous Studies of the Digital Textbook System

In the previous study, we proposed and designed the Quizzes based system to measure the contents of digital textbooks (Yin et al., 2016), we have already confirmed that by using our algorithm, the relevant learning contents of quizzes can be found.

In this paper, by using the algorithm and based on DITeL system, we developed a new system DITeL2. The DITeL2 can find the relevant learning contents from the digital textbooks, and feedback the learning contents to the teachers.

3. System Configuration

On the basis of the web-based digital textbook system using the e-pub format (Yin et al., 2017), we added some new functions that they can help teachers to improve the digital textbook in a much more objective manner based on the students' test scores.

As shown in Figure 1, this system configuration, there are two modules: one is for finding which questions that students got the lower scores, another is for searching relevant contents automatically (Yin et al., 2016).

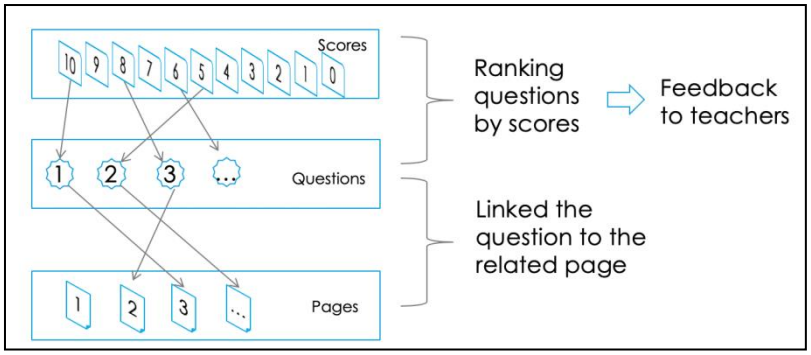

Figure 1. System Configuration

3.1 Question Scores Ratio Ranking Module

This module is used to find which question's average score ratio is lower. The average score ratio will be calculated for each question by using the following formula.

QASR (Question's Average Score Ratio) means the average score ratio of one question.
SCQ (Sum of the Scores of Question) means the summary of all the students' scores of the question.
CS (Counter of Students) means the count of all the students who have answered.

$$QASR = (SCQ/ CS)*100$$

3.2 Searching Content Module

The "lucene-gosen" was used to analyze what is relevant content to the digital textbook based on the questions of quiz. The "lucene-gosen" is a Japanese morphological analyzer. It creates index files based on the pages of the digital textbook, and then creates a search engine. In our study, the content of every question and correct options in a quiz, are seen as a search query. Using the search engine, we can find the relevant pages of a question. Then we link the question to the relevant pages in the digital textbook.

4. System Implementation

Figure 2 shows the main interface of DITeL2 for teachers. There are two new features in the DITeL2: one is for creating quizzes, another one is for automatic searching for the relevant pages of the digital textbook based on the questions of quiz.

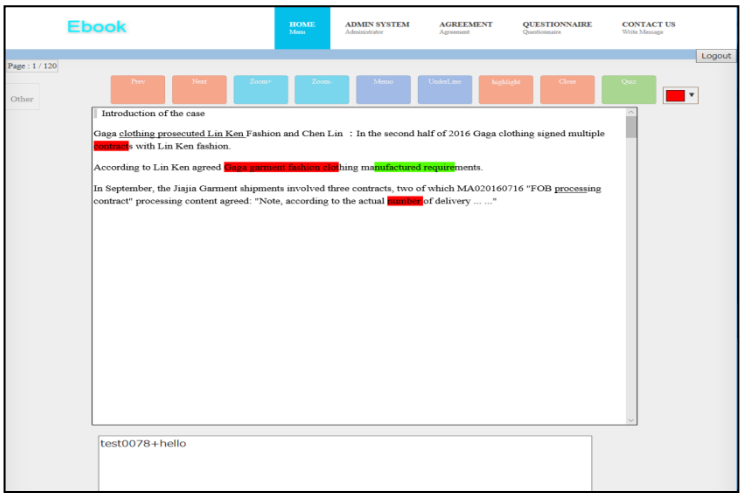

Figure 2. Teacher interface of DITeL2

4.1 The Interface for Creating Quizzes

In the first part, we designed three functions to register the contents and options of the quizzes, and the student's answers. So, teachers can design and build quizzes consisting of various types of questions, including single choice and true-false questions. And students can take quizzes in every lesson. These questions, options and answers are kept in separate tables on the database. The records of the answers are used to calculate the quiz scores, which are the percentage of average grades.

4.1.1 The Teachers' Interface for Creating Quizzes

In this function, teachers can insert the contents of questions and the IDs of correct answers to the questions, and the registered contents also include course IDs, textbook IDs (Figure 3). So that students can find the quiz they need to answer based on them. We can also modify and delete the questions that have already been registered. If somebody answers the question, the quiz scores ratio of the question will also be displayed.

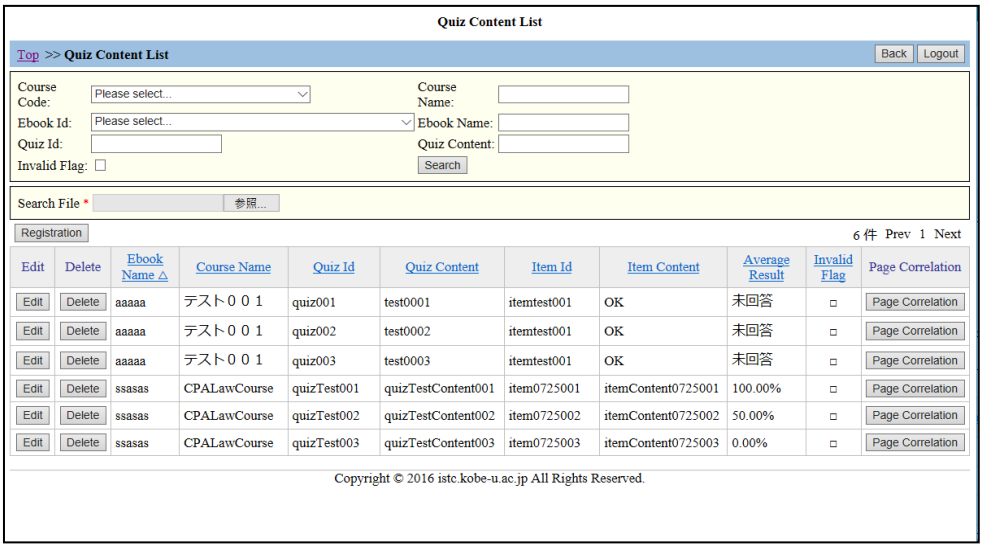

Figure 3. The list of questions

Teachers can insert the optional items of the questions, and these optional items can be used in different quizzes. We can also modify and delete the optional items that have already been registered.

4.1.2 The Students' Interface for Answering the Questions

In this function, students can find the quizzes they need to answer based on the course IDs and digital textbook IDs. Every time the students answer the quizzes, their scores are calculated and registered into the grade table of the students (Figure 4). They can also check the correct answers of the quizzes they took.

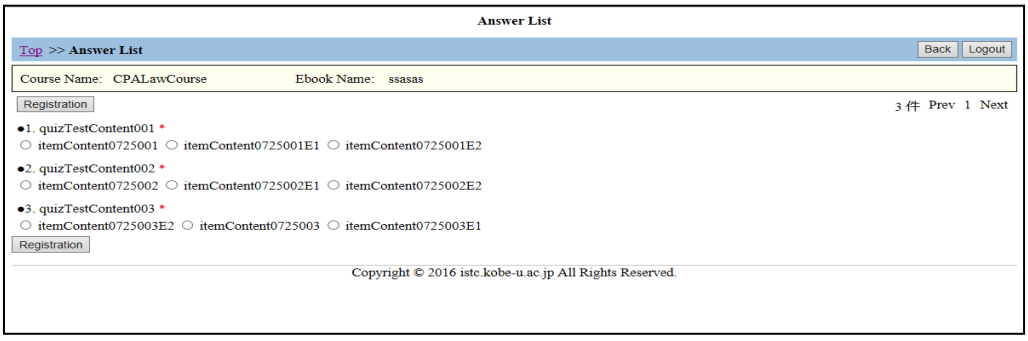

Figure 4. Questions that students need to answer

4.2 The Interface for Finding Relevant Contents by using Questions

In this part, according to the method described in the second module of the system, this function is designed to show the relevant pages. When you click on the "Page Correlation" button of every question on the questions list (Fig. 5).

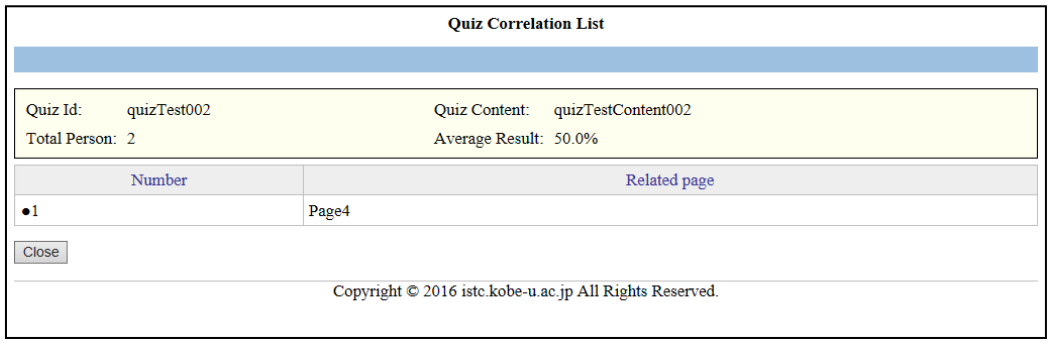

Figure 5. The relevant Pages

Then, the teacher can view which pages of the digital textbook the question is related to, and based on the student's quiz scores, the digital textbook can also be objectively modified.

5. Conclusion and future work

In the previous study, we designed an algorithm for finding the related digital textbook's pages to the quizzes. In this paper, based on the algorithm (Yin et al., 2016), we have developed a system DITeL2 to find the related pages of digital textbook to the questions of quizzes. The system has two new features: creating quizzes and finding the relevant contends of the quizzes from the digital textbooks.

Through the system, the teachers can create quizzes, and students can take a quiz in every lesson to test the level of mastery of their knowledge. According to the contents of the question of the quizzes, DITeL2 can find which contents have relevant with the question. If the grades ratio of the question is lower, the system can feedback the relevant learning contents to the teachers, and teachers can go to the relevant learning contents and revise the contents.

There are still many areas to be improved in our system. In the future, we will improve the system and apply it to the classroom to evaluate the effectiveness of the system.

Acknowledgements

Part of this research work was supported by the Grants-in-Aid for Scientific Research Nos. 16H03078, 16H06304, and 18H04125 from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan. We would like to thank all the people who prepared and revised previous versions of this document.

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