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Measuring & Evaluating Digital Textbooks through Quizzes

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Abstract: We currently utilize the Moodle learning management system for teachers and students who participate in the course 'College of Liberal Arts and Sciences' at Kobe University in Japan. Digital textbooks, reports, quizzes and questionnaires in this course were administered using Moodle. In this paper, we proposed to use quizzes to measure and evaluate those digital textbooks recorded on Moodle. At the beginning of our study, we examined the questions that students got lower scores, and then we found the related teaching materials of digital textbooks and feedback to the teachers in order to improve the content of these digital textbooks.

Keywords: digital textbooks, quizzes, educational data mining

1. Introduction

With the emergence of new generation smartphones such as the iPhone and Android-operated ones, it is no longer problematic to implement ubiquitous learning environments onto these high-powered devices. These smartphones utilize many advanced functions such as the multi-touch interface and the virtual keyboard (which allows users to type easier anywhere and anytime). Nowadays, smartphones can be held with just one hand for people to perform many functions on because the usability of these devices have been much improved as well as the physical size and weight of these have been designed better for our use.

During the past decades, many researchers focused on supporting students learning everywhere every time, which is called Computer Supported Ubiquitous Learning (abbreviated as CSUL) or context-aware ubiquitous learning (Yin et al., 2010; Hwang et al. 2009). Our current research is also focused on using digital textbook and quizzes to collect students' learning data everywhere every time and analyzing these data to support teaching. Teachers and students can use our system and read the digital textbook by using mobile devices such as iPad, iPhone, and Android.

In the digital age, digital textbooks, such as "living books", "talking books", and "CD-ROM books", can be conveniently accessed through Internet anywhere and anytime. Rainie, et al. (2012) indicated that the percentage of digital textbooks being read by learners has increased significantly from 17% in 2011 to 21% in 2012 in America. 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[1] (Yin et al., 2014).

By using mobile devices such as iPad, tablet PC or smartphones, anyone can easily create digital textbooks anywhere and anytime. However, many of these digital textbooks were created based

[1] http://www.mext.go.jp/

on the authors' experience in a subjective manner. Therefore, a number of problems have arisen in terms of the adoption of digital textbooks, for example:

1) How the quality of digital textbooks can be measured,
2) How the content of digital textbooks can be evaluated, and
3) How the content of digital textbooks can be improved.

In this paper, we examine the components of the digital textbooks, which should be revised by using students' quizzes test scores. If the average score of a question is very low, it can be considered that the related content is not explained well, and then the data mining technology is used to find the related content in the digital textbooks, and then, the related content will be feedback to the teachers to improve the digital textbooks. In this paper, we proposed to use quizzes to measure and evaluate the component of the digital textbooks recorded on Moodle. At the beginning of our study, we attempted to find which questions that students got lower scores. If the average score of a question is very low, it can be considered that the related content is not explained well. And then through the data mining technology, we attempted to find the related learning contents of digital textbooks and feedback to the teachers in order to improve the content of these digital textbooks.

2. Literature Review

2.1 Previous Studies of Data Collection Research on Digital textbook

Research has been 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 research on technological literacy concerning reading and writing skills (Ihmeideh et al, 2014, Korat et al., 2008). There have also been some studies on distribution systems of digital learning materials where questionnaire surveys were conducted on their usability (Siegenthaler et al., 2010) and the learners' learning styles (Rockinson-Szapkiw Rockinson et al., 2013).

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 material by collecting data such as attitude scale, interviews, field observations. These qualitative and quantitative data were collected from the sample, consisting of eighteen teachers and eighty students. However, the sample data is very smaller. However there have been very few research conducted so far In current research, using massive learning data (about 2600 students' learning data) is used to improve digital textbook.

2.2 Previous Studies of Data Collection

Collecting data is the first step in learning analysis. In May 2015, we thus performed a review of previous research to survey the categories that can be classified in terms of data collection, (Yin et al., 2013a; 2013b). Based based on the way of data collection source, previous studies on data collection could be classified into three categories (Yin et al., 2013a; 2013b):

A) Questionnaire/Quiz-based data collection. In this category, data are collected using a pre-designed questionnaire. Ho et al. (2013) used a questionnaire to investigate the teacher behavior of adopting mobile phone messages as a parent–teacher communication medium. Tan and Seah (2011) explored questioning behaviors among elementary students engaged in science inquiries via a computer-supported collaborative learning tool. Using a web-based portfolio assessment questionnaire, Chang et al. (2012) attempted to categorize global behaviors in a web-based portfolio assessment using the Chinese Word Segmenting System.

B) Manual data collection. In this category, a manual data collection system is opened to users, who can employ the system and consciously provide data about their learning behaviors. For example, Chiang et al. (2014) provided an augmented reality (AR) system to guide students in knowledge sharing in inquiry learning activities. In this approach, students capture images from an authentic environment and share these with others. Ogata et al. (2011) presented a system called System for Capturing and Reusing of Learning Logs, in which students can share their data learning logs

using learning memos, radio frequency identification tags, and cameras. Hwang et al. (2008) proposed use of a meta-analyzer to assist instructors in analyzing students' web-searching behaviors while using search engines for problem solving. In this system, students share their search logs with each other.

C) Automatic data collection. In this category, learning behaviors log data are automatically recorded while reading e-documents. Zeng et al. (2009) collected user reading behavior logs while reading e-documents to verify their course ontologies. Hou (2012) explored the behavior patterns of learners in an online educational role-playing game. The actions (gaming behaviors) conducted by these participants were automatically recorded in the game database.

For categories B and C, as some irrelevant data is also collected, it is necessary to weed out noisy data after collection (Ogata et al., 2016). For category A, the data can be used directly. The present work falls under this category. A digital textbook and quizzes of the Moodle system was used for this research.

3. Method

In Kobe University, there are 4 semesters in one academic year. The data used in this study were collected during a 'College of Liberal Arts and Sciences' (hereafter, abbreviated as CLAS) course at Kobe University in Japan. As shown on Figure 1, in this course, the digital textbook, report, quizzes and questionnaire were administered using Moodle (a free and open-source software learning management system)[2].

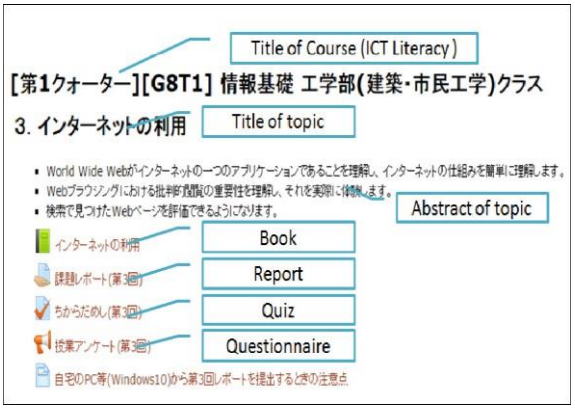

Figure 1, Using Moodle in the course

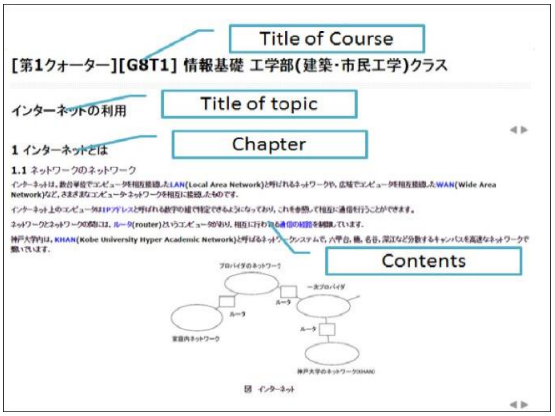

Figure 2, Using Moodle in the course

The CLAS course commenced eight years ago, the quality of the digital textbook was improved every year. The teachers who were in charge of the course changed the contents subjectively, and they spent a lot of time performing this task. Time limitation was a problem. Therefore, the system was redesigned to improve the digital textbook based on the educational data logs, which were the students' test scores. Based on the data, the teachers could improve the digital textbook in a much more objective manner. Our system can also help teachers to find the related contents automatically.

3.1 Participants and context

The CLAS course is a course completed in the first semester, which starts from April 2015 to May 2015. (6 times). This is a required course, which has been designed for about 2600 first-year students (ages 18 to 19) to acquire basic Information and Communication Technology (ICT) literacy at Kobe University. Along with information technology exercises, the course covers the study of information security academic manners of communication on the campus network KHAN (Kobe Hyper Academic Network) and the Internet. The program includes 6 items and takes place in the first semester.

[2] https://moodle.org/

The students were given the digital textbooks by using e-books within the Moodle system. By using Moodle, it was easy to create multi-page resources with a book-like format. Books can be printed entirely or by chapter. The book module within the system allows you to have main chapters and sub chapters (Figure 2).

3.2 Data Collection and Measure

The students took a quiz in every lesson to test the level of mastery of their ICT knowledge. Their exam scores were used in this study. Teacher can design and build quizzes consisting of a large variety of question types, including multiple choice, true-false, and short answer questions. These questions are kept in the question bank and can be re-used in different quizzes. Students could answer the question more than once. A record of the first time was used to calculate the quiz scores. One quiz has 10 questions, the scores (ranging from zero to one) of each question were used in this study.

3.3 Search related digital textbook by using questions

As shown in Figure 3, there are two modules in this system: one is for searching content module, another is for finding which questions that students got the lower scores.

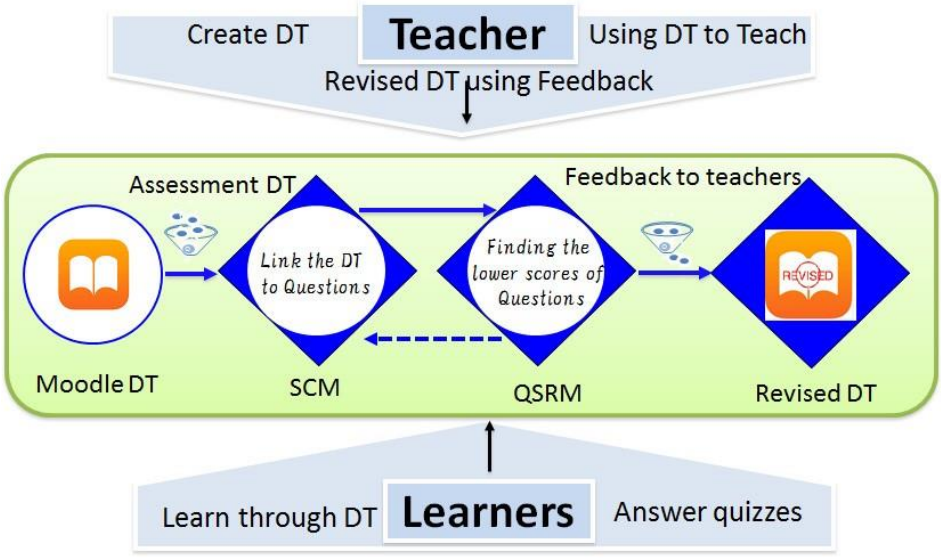

Figure 3. System Configuration

Searching Content Module (SCM), we used "lucene-gosen" to analyze digital textbook. The "lucene-gosen" is Japanese morphological analyzer. Then created index file based on the pages of the digital textbook, and then create a search engine. The content of every question in a quiz, were seen as search query. Using the search engine, we can find the related pages of a question. Then we linked the question to the related page in the digital textbook. If we cannot find the related page, we will return a "do not have related page" message.

Question Scores Ranking Module (QSRM), this module is used to find which question's score is lower. The average score will be calculated for each question by using the following formula, which QAS (Question's Average Score) means the average score of one question, SCQ (Sum of the Scores of Question) means the summary of all the students' scores of the question, and SS (Sum of students) means the count of all the students. These questions are ranked by all the questions' average scores, if the question's score is lower, then the question and its related page will be feedback to teachers. The teachers will improve the digital textbook based on the feedback.

$$QAS = SCQ/ SS$$

4. Analysis Sample

4.1 Link Question to Digital Textbook

This is an analysis sample of using SCM module. Figure 4.A is a question about "how to do if your computer is infected with a virus". By using SCM module, we find the related page (Figure 4.B) is about "Patterns of viral infection" and "What should we do when your computer is infected". From this example, we can know our system can find related page on the digital textbook to a question.

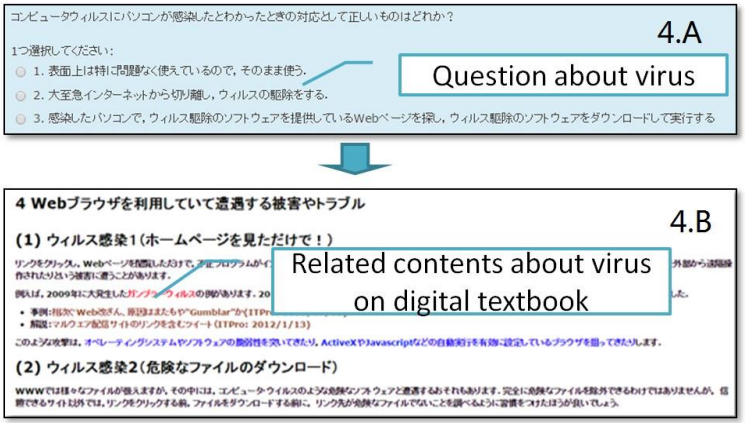

Figure 4.A Questions &
Figure 4.B Link Question to Digital Textbook

4.2 Feedback to Teachers

There is another analysis sample. There is a question, the wrong answer rate is 70%, we use the SCM to find the related pages, but the returned pages have very low similarity rate between the content of digital textbook and questions. We have checked the content of the digital textbook, we found that there is no related content about the question. This can be feedback to the teachers, and then teachers can improve the contents of digital textbook.

5. Conclusion and future work

Nowadays more and more traditional textbooks have been replaced by digital textbook. Digital textbooks have become a potentially effective pedagogic tool for supporting teaching, learning and scholarship.

Anyone can create digital textbooks anywhere, anytime, it is very convenient. However, this makes the quality of textbooks decline, as many of digital textbooks are created subjectively and individually. How to measure the quality of digital textbooks, and how to evaluate and improve the content of digital textbooks become very important problems.

In this paper, by using the related content of digital textbook to the quizzes' question, we propose to find which part of the digital textbooks should be revised. And the result will be feedback to teachers to improve the digital textbooks.

We have already confirmed that using our system can find the related digital textbook's page to the questions of a quiz. And the system can also give some feedback to teachers to improve the digital textbooks.

In the future, we will use the system in the classroom and evaluate the system effectiveness.

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