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The development of a learning management system for dental radiology education: A technical report

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ABSTRACT

Purpose: This study was conducted to suggest the development of a learning management system for dental radiology education using the Modular Object-Oriented Dynamic Learning Environment (Moodle).

Materials and Methods: Moodle is a well-known and verified open-source software-learning management system (OSS-LMS). The Moodle software was installed on a server computer and customized for dental radiology education. The system was implemented for teaching undergraduate students to diagnose dental caries in panoramic images. Questions were chosen that could assess students' diagnosis ability. Students were given several questions corresponding to each of 100 panoramic images.

Results: The installation and customization of Moodle was feasible, cost-effective, and time-saving. By having students answer questions repeatedly, it was possible to train them to examine panoramic images sequentially and thoroughly.

Conclusion: Based on its educational efficiency and efficacy, the adaptation of an OSS-LMS in dental school may be highly recommended. The system could be extended to continuing education for dentists. Further studies on the objective evaluation of knowledge acquisition and retention are needed. ***(Imaging Sci Dent 2017; 47: 51-5)***

KEY WORDS: Education, Dental; Computer-Assisted Instruction; Radiology

Introduction

In pedagogy, the adoption of information and telecommunication technology has significantly increased over the past decade, and these new tools are collectively known as e-learning. E-learning has many benefits, including flexibility in accessing content for the student, and the ability to reach a larger audience without increasing instructor time. This technical report describes the implementation of a web-based program for dental radiology education.

A learning management system (LMS) includes a software application for the administration, documentation, tracking, reporting, and delivery of e-learning courses. To build such an LMS, schools and faculties may need to purchase commercial software at great expense, develop it in-house, or outsource it. Given these obstacles, the Modular Object-Oriented Dynamic Learning Environment (Moodle) is an important open-source option among LMS platforms, and it is supported by a massive and active community with many plugins and options that allow customization.[1-3] According to the official Moodle site (http://moodle.org), it has been used to develop 74,297 sites in 232 countries. Therefore, Moodle was adopted for this study due to its low cost.

Modern medical education must deliver a very great amount of knowledge and information to learners, and the pace of change is rapid. To adapt to environmental changes in medical education, e-learning is spreading across the world.[3-5] E-learning allows much more flexible lessons for

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medical students, who must contend with busy schedules, and the varied multimedia resources and abundant visual materials that can be provided with e-learning are helpful for their education.

The use of e-learning has increased rapidly in dental education over the past decade.[6] Boberick[7] reported on the development and implementation of a web-enhanced interactive pre-clinical manual for a course on restorative techniques, and it successfully delivered information beyond the textual format. According to Handal et al.,[8] undergraduate students at dental colleges reported positive attitudes toward an LMS. Aly et al.[9] compared the effectiveness of an interactive multimedia courseware package versus standard lectures in orthodontics. The interactive multimedia program showed at least the same effectiveness as the standard lecture approach for undergraduate training. Mattheos et al.[10] reviewed the potential of information technology in dental education.

E-learning for dental radiology is still rather uncommon. Ramesh and Ganguly[11] introduced the Learning Catalytics program for interactive learning in oral and maxillofacial radiology, and they found that it improved bidirectional communication in a learning environment. Wu et al.[12,13] demonstrated that a web-based training method was valuable for education in dental radiology and could supplement the current educational practices without increasing teaching load. Moreover, it would further reinforce and improve students' ability to read dental images. According to the study of Kavadella et al. that developed and implemented a blended course on undergraduate oral radiology,[14] the students in the blended group performed better than the control group and the female students in the blended group performed better than the male students in the blended group.

In this study, we developed an LMS that could be used in dental radiology education, and confirmed the feasibility of the use of the system in practice for educating students.

Materials and Methods

The present study was approved by the Institutional Ethics Review Board of Seoul National University Dental Hospital (IRB No.ERI17005).

Web-based program development

Installation of Moodle requires a web server (in this study, an Apache server was used) with PHP (a web scripting language) and MySQL (a powerful database management system). As Moodle is open-source, PHP and MySQL are also open-source, and it is easy to install them using APM setup (http://www.apmsetup.com), which is an open-source software package used to set up web servers.

All the procedures for this study were accomplished using a server computer with the following specifications. The hardware specifications were Intel® Core (TM) i7-4770 CPU @3.40 GHz (8 CPUs) 3.40 GHz and 16.0 GB RAM. The software specifications were Windows server 2008 R2 Enterprise 64-bit (6.1, build 7600) OS, MySQL 5.0.45 Database, Apache 2.2 web server, and PHP.

The LMS was constructed with 4 parts: a glossary, wiki, forum, and quiz. First, the glossary function of Moodle was used to build a glossary. Important concepts and principles could be provided on the LMS and used before and during class by uploading video and photo materials. The availability of data in textbooks is limited, while the amount and scope of audiovisual materials available on an online education site can potentially be much greater. Second, the wiki function of Moodle allowed students to carry out team-specific tasks online, even if it was difficult for them to gather in one place when their schedules were different. This was especially helpful for the third- and fourth-year students during the clinical internship. Since the participation history was recorded, the instructor could determine the active participants and those who showed poor participation. Third, through the forum function, the instructor or a learner could ask and answer questions about difficult cases or share a particular case with other learners. The forum could be used as a window for communication during the semester. It could also be used as material for face-to-face classes. Face-to-face lessons lacked direct communication among learners and between teachers and learners, which could be supplemented through the forum function. Fourth, the quiz function of Moodle allowed repetitive dental X-ray diagnostic training. Moodle allowed the instructor to easily construct various types of quizzes such as cloze, essay, matching, multiple choice, random short answer matching, short answer, true/false, and description. It also provided various functions to help learners acquire and train their knowledge effectively. The instructor could specify a time period in which to allow quiz attempts and limit the time for finishing a quiz. It was also possible to select whether or not to allow multiple attempts. If the quiz was repeated several times, the instructor could choose which criterion to take into account in the evaluation, such as the highest score, the first-attempt score, and so on. The instructor

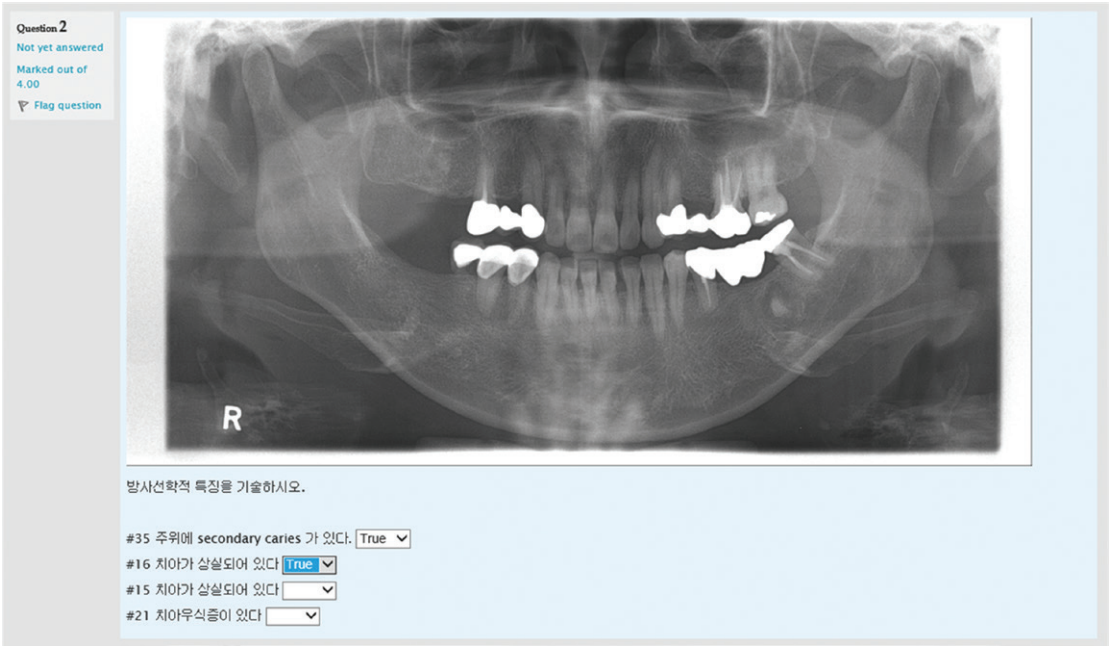

Fig. 1. Screenshot of a true/false quiz question. The prompt is "Describe the radiological features" and 4 true/false questions are presented. The true/false questions are "There are secondary caries in the left mandibular second premolar;" "The right maxillary first molar was lost;" "The right maxillary second premolar was lost;" and "The left central incisor has caries."

could shuffle questions or choices. The instructor could give instant feedback, or delayed feedback after students had solved all the problems.

Educational content development

Panoramic radiographs with radiographic interpretation approved by experts were collected from the Department of Oral and Maxillofacial Radiology of Seoul National University Dental Hospital. In order to protect the patients' privacy, the server was installed in the hospital and education was also conducted in the hospital. A pilot test was conducted by 3 clinical doctors. Figure 1 shows one of the quiz screens (Fig. 1). A panoramic X-ray is presented with a prompt, "Describe the radiological features," and 4 true/false questions are presented. The questions are as follows: "There are secondary caries in the left mandibular second premolar;" "The right maxillary first molar was lost;" "The right maxillary second premolar was lost;" and "The left central incisor has caries."

Implementation of the system

During their internship, third-year students in 2016 utilized the system for dental X-ray diagnostic training. Students were provided with 100 panoramic images and each image was accompanied by several questions. Questions were chosen that could assess students' ability to diagnose dental caries. Using the function of log analysis, we investigated when and how long students had accessed the system. We compared and analyzed students' quiz results and reviewed students' answers.

Results

Building a dental radiology LMS using Moodle was feasible at a low cost and was expected to be effective when introduced into the current students' curriculum. Among the functions of Moodle, the quiz was considered to be effective for dental X-ray diagnostic training. By having them answer questions repeatedly, it was possible to train students in the interpretation of panoramic images sequentially and thoroughly.

The students were able to undergo dental X-ray diagnostic training with the latest X-ray images taken in real clinics, rather than old X-ray images in textbooks. Because the number of X-ray images was abundant, repeated learning was possible. Moreover, since the students could access the LMS anytime and anywhere, they were able to learn outside of the given class time. This could be a great advantage because of the lack of time allocated for dental X-ray diagnostic training.

One weakness of the conventional teaching method is that individualized education may not be possible. Using

LMS, the instructor was able to measure the understanding of the learners from their quiz results and could refer to these results in subsequent lectures.

Discussion

In this study, we introduced Moodle for instructors who aimed at more effective teaching by applying e-learning to dental radiology education, and proposed an online LMS design that could assist offline lectures. The goal was to guide instructors to build an effective blended learning environment that uses online and offline material complementarily. The most important variable in designing the online learning site is to design it to effectively complement the offline learning in accordance with the nature of the subject. The design can be changed according to such parameters. It is important to set up the LMS function to match the nature of the course in order to build an online site that will help in dental radiology education. We examined how existing offline dental X-ray diagnosis education was mainly carried out and what could be complemented in terms of learning efficiency, as well as how to overcome the current problems by using Moodle functionality. Improvements in learning effectiveness and increases in communication between instructors and students are expected from blended learning in online and offline environments.

The LMS was considered to be advantageous for basic dental radiology education as well as dental X-ray diagnosis training. Given the potential for individual differences in learning ability, it might be possible to reduce these differences by providing lessons prior to class or allowing for learning through online materials after lectures. Online materials could be studied repeatedly without constraints of time or place.

Despite the educational potential of e-learning, the criticism has been leveled that it cannot bring about a fundamental change in the actual teaching of classes, and instead, that the existing teaching-learning method should be strengthened. In addition, research on e-learning has been criticized for focusing on only the output of the change rather than on the process of the class, thus failing to solve problems that arise in the actual course. Alternatively, there is a view that e-learning should be accepted as a new educational alternative according to the trend of the times. This view may confront psychological resistance and conservative voices that advocate for lecture-oriented education. Therefore, it is necessary to prepare the instructional plans and guidelines for teachers to appropriately restructure face-to-face learning.

This study showed the feasibility and effectiveness of dental radiology education using Moodle. Moodle also provided a function that analyzed student usage patterns. This could be helpful for understanding student differences. Pre-learning patterns helped a lecturer to understand students' levels of understanding, which could be reflected in the lectures. It is necessary to study how to encourage students who are not accustomed to online learning or motivated to engage. Further studies on objective evaluations of knowledge acquisition and retention are required. The introduction of online education into dental radiology education would have a major impact on the education process, and it could be extended in various ways, such as to continuing education for dentists.[15]

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