Fusion of E-Textbooks, Learning Management Systems, and Social Networking Sites: A Mash-Up Development

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Abstract Online education has provided good opportunities for educationally disadvantaged people. However, some traditional learning management systems (LMSs), the base systems of online education, had the limitations in offering standardized education for diversified learners with different skills, objectives, abilities, preferences, and backgrounds. In addition, the traditional LMSs, which required a constant connection of the Internet, could not be used where it is not available, that is, in the half of the world. Thus, we developed a new learning platform for large-scale online courses (LSOC), called "the Creative Higher Education with Learning Object (CHiLO)". CHiLO is a comprehensive, open-network learning system which can realize e-textbooks, competency-based education (CBE), digital badges, and social learning. CHiLO can contribute to future

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research on next-generation learning content based on e-books and a flexible, diversified learning environment for people worldwide.

Keywords Large-Scale Online Courses (LSOC) · E-textbook · Competency-Based Education (CBE) · Digital badges · Social learning

1 Introduction

Education for All (EFA) is a large project and major challenge issued by the United Nations Educational, Scientific and Cultural Organization (UNESCO). This movement involves a global commitment to provide basic quality education for all children, youth, and adults (see http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-all/). However, accomplishing EFA's goal through traditional teaching methods—e.g., building a massive number of brick-and-mortar schoolrooms and supplying many teachers to educate the world's masses—is not realistic. Online learning can disseminate education worldwide at a low cost. In fact, massive open online courses (MOOCs), a type of large-scale online course, can radically contribute to enhancing opportunities for higher education around the world.

However, MOOCs incorporate potential issues found in traditional learning management systems (LMS). Traditional LMSs disregard two types of diversity observed in large-scale online courses (LSOCs); the standardization of education in a learning environment including diverse students and the geographical divide in the digital environment.

Considering these issues, we have developed the Creative Higher Education with Learning Object (CHiLO) learning platform. CHiLO aims to provide a device-agnostic, ubiquitous learning environment through e-textbooks. It possesses effectively high portability in the electronic publication 3.0 (EPUB3) format and a comprehensive, open-network learning system created by combining various existing technologies, such as LMSs and learning resources, which includes open educational resources (OER) in open-network communities such as social networking services (SNSs).

In this study, we report on CHiLO's architecture and its possibilities based on some experimental results.

2 The LMS in Large-Scale Online Courses

2.1 Standardized Education in Large-Scale Online Courses

In LSOCs, learners have different skills, objectives, abilities, preferences, and backgrounds. Despite that, a traditional LMS offers all learners the same content during the same term and the same assessments with the same criteria (Mintz 2014, Mazoue 2013, Wilkowski et al. 2014). The post-MOOC movement observed after MOOCs gained popularity in 2012 seemed to struggle with standardized education.

- Competency-based education (CBE) focuses on effective learning for adults, e.g., working and self-supporting students, over a short amount of time (Sturgis et al. 2011).
- The Task Force on the Future of Massachusetts Institute of Technology (MIT) Education provided further insights into unbundling education, which involves using different roles—such as classrooms, labs, and mentoring—as modules. A module is defined by its corresponding outcomes, e.g., its instruction and assessment. Each module is re-bundled with competency-based assessments or new assessment methods relating directly to measurable outcomes for a class or module (Force 2013).
- The Nanodegree (see https://www.udacity.com/nanodegree), conferred by Udacity, a for-profit educational organization with a MOOC platform, provides learners with bite-sized bundles of knowledge and immediate motivation for acquiring a degree. Furthermore, its curriculum is designed for acquiring specific business skills over 6 to 12 months (10–20 hours/week) for $200 a month (Porter 2014).

2.2 Geographical Digital Divide

Another challenge of traditional LMSs is the geographical digital divide. Most LMSs are based on web services requiring Internet access. However, about 60% of all people globally do not have Internet access (ITU 2015). Furthermore, 80% globally do not have personal computers (The World Bank 2012). Therefore, online learning that requires a constant Internet connection is unavailable to them.

In contrast, mobile communication devices are ubiquitous. The International Telecommunication Union(ITU) stated, “Globally, mobile-broadband penetration will reach 32% by the end of 2014—almost double the penetration rate just three years earlier (2011) and four times as high as five years earlier (2009)” (2015). Mobile communication devices that provide satellite communication and a personal area network (PAN), such as Bluetooth, which offers a traditional telephone infrastructure with Internet access, have proliferated worldwide even in areas without regular Internet access. Therefore, the use of mobile devices could provide a solution to these challenges.

Nevertheless, mobile devices present different challenges (Deb 2012). Mobile devices’ essential problems are their small screens, lack of keyboards, network speed, reliability, short battery life, and limited content and software applications.

3 The Architecture of CHiLO

3.1 CHiLO’s Technology Components

CHiLO provides flexible, diversified service for online learning based on various computer network environments, devices, learners’ skills with e-books, CBE, digital badges, and social learning (see Fig. 1).

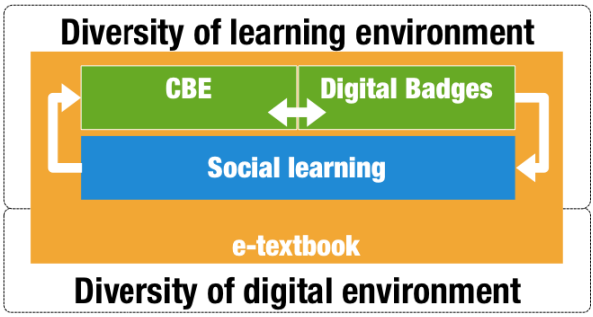

Fig. 1 CHiLO's technology components

CBE, Digital Badges, and Social Learning

We can expect to provide a flexible approach for diverse learning environments by combining CBE, digital badges, and SNS.

The CBE approach provides short-term learning content based on competencies according to the learner's skills, objectives, abilities, preferences, and background. In addition, learners can demonstrate acquired skills and knowledge in CBE by using digital badges. Digital badges, which are part of a conventional system that has been successful in motivating participants by showcasing challenges, have been used in SNSs such as FourSquare and Gamification (Deterding 2012). CBE using digital badges is focused on micro-credentials, which could be connected with learning paths in current efforts to demonstrate learners' mastery of those competencies (Sturgis at al. 2011).

Many studies strongly suggest that cooperative learning is more effective than individualistic learning in contributing to motivation, raising achievement, and producing positive social outcomes (Chen and Bryer 2012). In LSOCs, learners do not learn from a tutor but rather learn on their own with learning materials. A learner who earns digital badges frequently exchanges information with other learners in their communities as a "connoisseur" (see "The CHiLO community" below). In this way, social learning provides the functions of discovering, sharing, aggregating, and repurposing.

e-textbook

With the advent of the EPUB3 format, which offers greater sourcing flexibility, e-books can now include media-rich, interactive content. In one package, an e-textbook can contain all the resources a student needs (Smith and Kukulska-Hulme 2012). Therefore, we can expect to close the geographical digital divide by bundling CBE, digital badges, and social learning into e-books.

Developed by the International Digital Publishing Forum (IDPF), EPUB3 is a distribution and interchange format standard for e-books (Polanka 2013). EPUB3 is not only device-independent but also available on- or offline so that a file can be opened on a PC, tablet PC, or mobile device as long as an e-book reader application is installed.

In education, tutors can easily repurpose and adapt learning materials offered in the EPUB3 format to improve learning outcomes. In addition, they offer a way to avoid vendor lock-in (Belfanti 2014). New generation e-textbooks, such as EDUPUB and EPUB3, show equal or greater educational effects than traditional LMSs. Furthermore, e-textbooks offer unique advantages for distance-education students as well as situational reading (Smith and Kukulska-Hulme 2012). Thus, they have the potential to not only close the geographical digital divide but also provide diverse learning environments.

3.2 CHiLO's Learning Components

CHiLO, which is based on e-textbooks, aims to offer an affordable, scalable design with regard to LSOCs. It consists of the following six components (see Fig. 2):

- CHiLO books adopt a "mash-up" approach to e-textbooks in the EPUB3 format.
- CHiLO lectures are based on one-minute nano lectures embedded in CHiLO books.
- CHiLO badges in CHiLO books provide authentication and certification using Mozilla Open Badges (see http://openbadges.org).
- CHiLO communities offer learning communities built in social networking services, bulletin boards, and chat rooms.
- CHiLO analytics recommends a learning environment suited to the individual learner.
- The CHiLO reader is the dedicated CHiLO book-browsing software program.

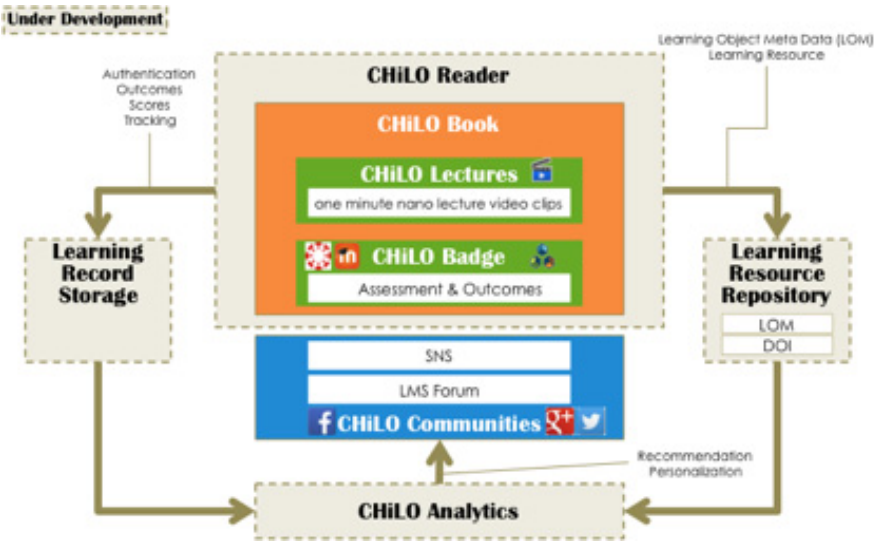

Fig. 2 CHiLO's Component

The CHiLO Book

CHiLO books, a core CHiLO component created using EPUB3 e-textbooks, contain media-rich content, including graphics, animation, audio, and embedded video. Based on the micro-credential method, CHiLO books consist of the learning materials used during a classroom hour. Those who complete a CHiLO book receive a CHiLO badge as a certificate of completion.

The CHiLO Lecture

CHiLO lectures contain videos with scripts, quizzes, and other learning materials. Videos offer one-minute nano lectures. This concept emerged from an experiment revealing that online learners' average viewing time is approximately one minute (Hori et al. 2013). A CHiLO lecture is equivalent to one section in a traditional textbook. A CHiLO book contains approximately 10 CHiLO lectures, and a standard CHiLO course, which is comparable to a traditional university course with one academic credit, consists of 10 CHiLO books.

The CHiLO Badge

Performing indirect assessments, e.g., of learning time and academic workload, is difficult in LSOCs. Although CHiLO adopts a direct-assessment approach for learning outcomes, completion of a CHiLO course is measured in standard course hours corresponding to academic credits.

Whenever a learner completes a CHiLO book, he or she receives a CHiLO badge, which is a simple mechanism to measure successful outcomes in CHiLO. When a tutor wishes to check a learner's progress, the tutor asks the learner to present CHiLO badges, thus removing the need to confirm using indirect assessment tools, such as grade books or tracking past results or test scores.

The CHiLO Community

The CHiLO community provides a social network function. Learners may share a downloaded a CHiLO book and have discussions on an open SNS on the Web, e.g., Facebook and Twitter.

The CHiLO community is comprised of many learners and a few tutors, known as "connoisseurs." These tutors act as substitutes for teachers. A learner who has studied and completed CHiLO books in a specific field can became a connoisseur. The connoisseur and learner are on equal footing, so the connoisseur often exchanges information with learners in the community.

In the CHiLO community, a learner does not learn from a tutor but rather learns independently using CHiLO books as a learning resource. In this way, learners are constantly required to find suitable CHiLO books within the community. The CHiLO community provides methods for discovering, sharing, aggregating, and repurposing CHiLO books for learners.

The CHiLO Analytics
CHiLO analytics recommend learning content, learning methods, and a learning community that fits the individual learner's purposes and preferences. This is made possible by analyzing the learner's activity logs, which are stored in the learning record storage (LRS), and the Institute of Electrical and Electronics Engineers (IEEE) Learning Object Metadata (LOM) in the learning resource repository.

The CHiLO Reader
The CHiLO reader is an e-book reader application optimized for CHiLO books. Its purpose is to enhance the usability of CHiLO books. The CHiLO reader is compatible with three types of CHiLO books: embedded, EPUB3-based, and web-based. The CHiLO reader also records learning history (outcomes, scores, tracking, etc.) when it is offline and sends the history to a learning record storage (LRS) when it goes online.

4 Demonstration Experiments

4.1 Experimental Methodology

In collaboration with the Open University of Japan (OUJ) and the Japan Foundation, we produced 10 CHiLO books titled "Nihongo Starter A1 (NSA1)," which include 10 successive lessons for those learning Japanese for the first time.

As a demonstration experiment, we distributed two types of CHiLO books—EPUB3-based and Web-based—from the NSA1 series over approximately one year (April 2014 to March 2015) at no charge through three different distribution channels (Table 1). One of the distribution channels, the OUJ-MOOC site, is a platform supported by JMOOC, a MOOC provider in Japan (see http://www.jmooc.jp/en/about/).

Table 1 Distribution channel

Distribution channel	EPUB3-based	Web-based
OUJ-MOOC site	✓	✓
iBooks Store	✓	N/A
Google Play	✓	N/A

4.2 Results

The results of the demonstration experiment are listed below:

- In all, 17,590 EPUB3-based CHiLO books and 5260 web-based CHiLO books were downloaded in 104 countries using the three distribution channels.
- Comparing the number of Lesson 1 downloads (6774 books) to Lesson 10 downloads (1304 books), Lesson 10 downloads were only 19% of those for Lesson 1.

- Of the learners, 3156 took assessment examinations at least once. Of the learners who took the online test for Lesson 1 (786 people), 18% (145 people) went on to complete all 10 lessons and earned 10 badges.
- In all, 3181 learners participated in the CHiLO communities (Classes 1–5) on Facebook. Further, learners made 1219 posts in the communities, posted 4046 comments, and gave 5808 "likes."." Participants posted about their positive experiences and showed off the badges they had earned. Furthermore, participants who had completed the course tended to provide helpful suggestions to participants who were still taking the course.
- With regard to the analysis of device-specific access to the Moodle quiz module, we divided access logs into EPUB3-based and web-based CHiLO books; for web-based books, about 69% of all learners' access was from PCs; for EPUB3-based books, approximately 73% of all learners' access was from mobile devices, such as smartphones and tablet PCs. The questionnaire results from those who earned badges in this demonstration experiment (n = 105) showed that 50.5% (53) of the respondents used EPUB3-based CHiLO books in some way (see Fig. 3).

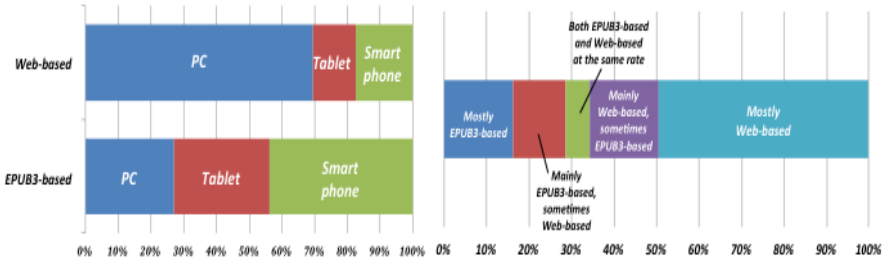

Fig. 3 Ratio of people who responded to the questionnaire regarding CHiLO book format and devices (left). Questionnaire results: Which CHiLO book did you use, EPUB3-based or web-based? (right)

5 Discussion

5.1 Completion Rate

We obtained positive results showing that 18% of the learners who attempted the Lesson 1 examination completed the course. This result is good, considering that the typical completion rate in MOOCs is said to be less than 10%. However, a rigid comparison is not possible because learners did not have to declare enrollment when they began learning in this pilot study.

5.2 Traditional e-book Reader

Based on the demonstration experiment results, we found that a kind of mutual learning occurred in the learning community: Learners who had completed the course tended to provide helpful suggestions to learners who were still taking the course. CHiLO seemed to cultivate each learner's individuality, as opposed to standardized education.

With regard to geographical digital divide issues, CHiLO offers affordable formats for people in 104 countries, including those in rural countries. In addition, learners selected web-based or EPUB3-based CHiLO books and chose to use the books on PCs or smartphones according to their preferences and lifestyles. This result demonstrates that CHiLO could provide flexible, diverse learning environments that are also device-independent, network-independent, and anytime–anywhere.

In the experiment, learners reported that video lectures did not play or that they could not access some quizzes at the ends of chapters in the EPUB3-based CHiLO books. Most e-book readers do not support embedding videos that meet requirement specifications of EPUB3. Quizzes written in JavaScript or JSON do not work in many e-book readers in an offline environment. This experiment could not be conducted with CHiLO analytics or the CHiLO reader, but these technical difficulties associated with traditional e-book readers are expected to be resolved soon.

6 Conclusion

A kind of mutual learning occurred in the learning community, thus addressing some challenges of standardized education. Learners who had completed the course tended to provide helpful suggestions to learners who were still taking the course. In addition, Spanish-speaking learners volunteered to form a learning group in which they translated the NS A1 learning materials into Spanish. The CHiLO seems to cultivate each learner's individuality, as opposed to standardized education.

E-textbooks, such as CHiLO books, are now being introduced into education, and their improvement has been widely studied. The IDPF has proposed that the EDUPUB format meet next-generation learning-content requirements based on the EPUB3 format (see http://www.idpf.org/epub/profiles/edu/spec/). However, the implementation of these books is still being discussed. Our study is meaningful to not only future research on next-generation learning content based on e-books but also efforts to offer flexible, diversified learning environments for people all over the world.

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