Building an Online Adaptive Learning and Recommendation Platform

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Abstract. In the traditional e-learning environment lack of immediate learning assistance. This online adaptive learning and recommendation platform (ALR) provide tracking tool for instructors to "observe" or "monitor" individual students' learning activities. Students can learn through the ALR platform using the learning path to get the immediate assistance. Individual students' learning strengths and weaknesses can be revealed via analyzing learning activities, learning process, and learning performance. Related analysis results can be utilized to develop corresponding automatic interventions in order to achieve goals of adaptive learning. Therefore, the purpose of this study aims to construct the concept map for adaptive learning, provide educational recommender for individual students. On the top of these prior projects, this project will develop the following intelligent components: (1) personalized dynamic concept maps for adaptive learning; (2) personalized learning path recommendation; and (3) context-based recommendation for meeting personal learning needs. Each of components will be strictly validated to ensure its practicability. This study introduce the ALR platform.

Keywords: Concept mapping · Adaptive learning · Educational recommender

1 Introduction

Online learning has become popular in recent years, especially the online self-regulated learning platforms (such as Coursera, edX, and Udacity). For example, the self-regulated learning platform (www.junyiacademy.org) provides over 7,600 free learning videos for junior and senior high school students in Taiwan (Junyi Academy 2016). However, how to select suitable (meeting with personal learning needs and capability) learning materials from a huge amount of learning resources becomes a challenge for students. In addition, these platforms heavily replies on learner's autonomy. A standardized package cannot meet learning needs from individual students. Therefore, it is crucial to provide "customized" learning materials or paths in order to cultivate successful students.

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However, in the self-regulated learning platforms, students encounter two major learning barrier—metacognition and information overload (Riverin and Stacey 2008). Learners are usually designed to accept a huge amount of learning resources, including videos, written lectures, and online discussions. However, learners might not have sufficient knowledge and ability to diagnose personal learning needs or learning weakness and then locate suitable correct learning resources.

In order to overcome above challenges, adaptive learning has attracted attentions by scholars and educators (Brusilovsky 2003). Adaptive online learning environments emphasizes the following advantages to attract learners:

1. Instant feedback: studies have shown that the immediacy and frequency of feedback significantly influences learning performance. Adaptive online learning platforms usually embed mechanisms aiming to provide instant feedback (Šimko et al. 2010).
2. Personalized learning: theoretically, more than one learning paths can achieve the same learning goals. An adaptive (smart) learning system can diagnose student's learning preferences and current status in order to recommend personalized learning path (Chen 2008).
3. Self-paced learning: on the adaptive learning platforms, students will not be blamed by failing in basic questions. On the other hand, students can skip units which have been mastered and focus on their own learning weaknesses. Quick or slow learners can take their own pace without considering others (Chan et al. 2001).

With the support of Taiwan's Ministry of Economic Affairs, this project aims to develop online adaptive learning and recommendation platform (ALR). The purpose of this study is to introduce the framework of the project and the adaptive learning and recommendation platform.

2 Literature Review

The major components of the adaptive learning systems contain two parts: the component of dynamic concept map and the component of context-based recommender. The framework will be presented in a latter section, here will discuss prior work in concept map and education recommender systems.

2.1 Concept Map

Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Concept maps were developed in 1972 in the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science (Novak and Musonda 1991). Concept map presents concept structures via nodes and connections. Nodes represent concepts and connections between two nodes represents relationships. The relationships can be non-, singular-, or bi-directional. In a concept map, the entire "map" is shown as a hierarchical structure. Generic concepts

are located at the upper levels and concrete, specific concepts are located at the lower levels. The sequence of learning order (i.e. learning path) becomes more organized and systematic via concept map.

2.2 Education Recommender Systems

Burke (2002) defined recommender systems as any systems which can generate personalized recommendation in order to provide guidance among choices. The recommendations usually contain interesting or useful options. In today's online learning, learners are exposed to a huge amount of learning resources. Therefore, learners need an effective mechanism which can recommend suitable resources. Educational Recommender systems also attracted lots of research efforts in recent years (such as Park et al. 2012; Santos 2011). Buder and Christina (2012) suggested educational recommender systems should focus on the non-technical factors, instead of the algorithms. The algorithms used in the e-commerce might not be suitable for educational environments. The systems should combine with education related theories, especially when the system applies to non-traditional learning environments. Vasilecas (2007) also suggested to combine multiple algorithms in order to avoid the issues of cold start and data sparsity. In addition, in order to achieve the goal of personalized learning, learning recommendations should take individual learners' situation into consideration in order to provide the most appropriate recommendations.

3 The Framework of the Adaptive Learning Platform

Figure 1 shows the framework of the whole project. The platform contains the following major components:

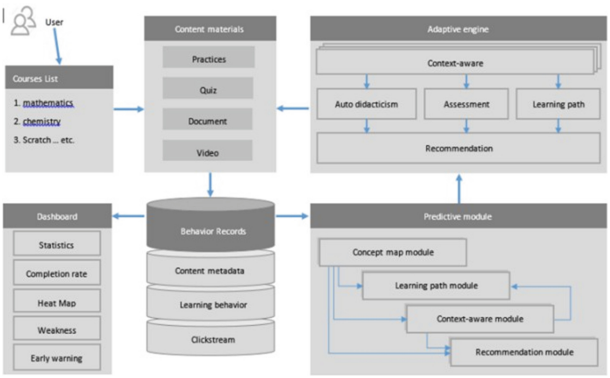

Fig. 1. Framework of the adaptive learning platform

- **Course list:** a database table which stores courses offered on the platform;
- **Content materials:** a cloud-based database which stores course materials. The major formats of course materials include instructional videos, written course materials, and assessment;
- **Behavior records:** in order to track student's learning behaviors performed on the platform, this project adopts xAPI standards (reference here) to store content metadata, learner metadata, learning behaviors, and clickstreams;
- **Adaptive engine:** the engine is used to generate real-time recommendations based on learner's learning contexts. Recommendations will be triggered by personalized learning path (context 1), by learner's self-learning behaviors (context 2), or by learner's assessment results (context 3). The sequence of personalized learning path is based on dynamic concept map; (e) Predictive module: the module implements computations of dynamic concept map and context-based recommendation and stores results in the database;
- **Dashboard:** the dashboard module visualizes real-time results for instructors and students to support educational decisions.

4 Discussion

Table 1 compares adaptive learning platforms on the market. Most platforms provide modules of concept map and learning path. However, learning path and concept map are fixed, not personalized. In addition, only Renaissance learning and this project offers recommendation on the platform. The comparison indicates current adaptive learning platforms mainly focus on the content development. The smart "adaptive" components are still not the major functions of the platform.

Table 1. Comparisons of adaptive learning platforms

Adaptive learning platforms	Concept map	Learning path	Recommendation
Renaissance learning			✓
Knewton	✓	✓	
RealizeIt		✓	
ALEKS	✓	✓	
Smart Sparrow	✓		
This project	✓	✓	✓

Although the platform can construct personal concept map from the results of pre-test, the system should have another mechanism to compare the student's concept map structure with the expert's. If the structures have huge differences, which mean the student's concept map might contains significant false concepts or misunderstanding. Then using expert's concept map structure to guide the student's learning can obtain better learning outcomes.

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References

Brusilovsky, P.: Adaptive and intelligent web-based educational systems. Int. J. Artif. Intell. Educ. **13**(2–4), 159–172 (2003)

Burke, R.: Hybrid recommender systems: survey and experiments. User Model. User-Adap. Inter. **12**(4), 331–370 (2002)

Chan, A.T., Chan, S.Y., Cao, J. (2001). SAC: a self-paced and adaptive courseware system. In: Proceedings IEEE International Conference on Advanced Learning Technologies, 2001. pp. 78–81. IEEE (2001)

Chen, C.M.: Intelligent web-based learning system with personalized learning path guidance. Comput. Educ. **51**(2), 787–814 (2008)

Junyi Academy (2016). http://www.junyiacademy.org/

Novak, J.D.: Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations. Lawrence Erlbaum and Associates, New Jersey (1998)

Park, D.H., Kim, H.K., Choi, I.Y., Kim, J.K.: A literature review and classification of recommender systems research. Expert Syst. Appl. **39**(11), 10059–10072 (2012)

Riverin, S., Stacey, E.: Sustaining an online community of practice: a case study. Int. J. E-Learning Distance Educ. **22**(2), 43–58 (2008)

Santos, O.C.: Educational Recommender Systems and Technologies: Practices and Challenges. IGI Global, Hershey (2011)

Šimko, M., Barla, M., Bieliková, M.: ALEF: A Framework for Adaptive Web-Based Learning 2.0. In: Reynolds, N., Turcsányi-Szabó, M. (eds.) KCKS 2010. IAICT, vol. 324, pp. 367–378. Springer, Heidelberg (2010). doi:10.1007/978-3-642-15378-5_36