Design Principles of The Educational Recommendation System in Higher Education

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Abstract: The purpose of this study is to identify the needs of instructors and learners for an educational recommendation system (ERS) and develop the design principles of the ERS. We interviewed 17 learners and 4 instructors and surveyed 600 learners in a university. Based on the interviews and surveys, we created an ERS framework and proposed five design principles for educationally desirable recommendations of courses. This study implies that the ERS should be different from recommendation systems for business because the ERS should be responsive to the educational needs of learners as well as their preferences.

Keywords: Artificial intelligence, personalized learning, recommendation system, higher education

1. Introduction

Recommendation systems are much useful to support making a decision when there are a lot of choices. For example, Netflix recommends personalized movies based on customers' viewing records and their evaluation of movies. Although the number of recommendation systems is increasing for business, there is a lack of research on educational recommendation systems (ERS), which have different characteristics from the former. The ERS needs to consider educational purposes and the needs of learners, which are not emphasized in the commercial recommendation systems (George & Lal, 2019; Santos & Boticario, 2015). Preference-based recommendation systems tend to have the problem of filter bubbles, which lead to a biased perspective on a topic, but the ERS should help learners to understand diverse perspectives different from their own. In addition, the ERS should contribute to the improvement of knowledge and skills, focusing on what learners need rather than what they like. The purpose of this study is to explore the ERS design principles for choosing courses. For this purpose, this study not only reviewed previous studies but also analyzed the needs of learners regarding the ERS.

2. Literature Review

In previous studies, the ERS is used mainly for three purposes: course selection support, academic achievement improvement, and career support. First, the ERS can support the selection of courses with personalized recommendation according to learner characteristics, interests, and preferences (Chen et al., 2020; Ng & Linn, 2017). Second, the ERS can recommend a course that allows learners to get higher achievements by predicting their course scores (Bozyiğit et al., 2018). Third, the ERS can help learners to achieve their career goals by recommending courses related to their future careers (Kaur et al., 2019). Although a growing number of studies have developed recommendation systems in the context of higher education, they seldom investigated the influence of the system on learning behaviors and competencies of learners. It is not educationally desirable that learners take only courses that they prefer or can get higher scores. It is necessary to investigate the design principles of the ERS, which can enhance meaningful learning in higher education.

3. Methods

This study interviewed 4 instructors and 17 learners and conducted an online survey (n=600) at a university in South Korea. The interviews were carried out for 60 mins to investigate multiple perspectives on the ERS and to explore learners' experience of choosing a course. The online survey included questions of how learners choose major and liberal art courses, what challenges they encounter in choosing a course, and what functions they need in the ERS. The survey items were developed based on the interviews with instructors and learners, using a 5-point Likert scale (0: strongly disagree, 5: strongly agree). Based on the interviews and surveys, we created five design principles of the ERS.

4. Findings

4.1 Needs Analysis

This study found three themes that should be considered when developing the ERS. First, when choosing a course, learners considered a few criteria: competency development, curriculum, interest, recommendation of friends, career plans, the amount of coursework, and expected grades. Learners considered the development of their competencies as the most important criterion in choosing a major course, whereas they considered their interest most importantly in choosing a liberal art course. Second, learners were likely to have difficulties in choosing a course because there was a lack of information about courses. They also did not have enough opportunities to explore diverse courses. Third, the functions they needed in the ERS included detailed information about courses, course filtering based on learner schedule, search for courses, explanation of recommendation, and so on (see Table 1). In the interviews, learners emphasized that the ERS should explain why a course is recommended to them, but there was a disagreement on whether class reviews of past students should be included in the ERS. The class reviews reflected the interests of learners (e.g., the amount of study, and the possibility of getting high grades), but they were not always educationally meaningful.

Table 1. *Learners' needs of functions in the educational recommendation system*

Function	Major course		Liberal art course	
	M	SD	M	SD
Detailed information of courses	4.2	0.8	4.1	0.9
Course filtering based on learner schedule	4.2	0.9	4.1	0.9
Search for courses	4.0	0.8	4.1	0.9
Explanation of recommendation	4.0	0.9	4.0	0.9
Personalized recommendation	3.9	0.9	4.0	0.8
Connection with courses registration webpage	3.9	0.9	3.9	1.0
Information of past students	3.9	1.1	3.6	1.2
Paths of taking courses	3.9	1.0	3.3	1.1

4.2 Design Principles

The ERS framework is presented in Figure 1. The learners' needs of the ERS are reflected in the "recommendation system" part of Figure 1, and the ERS framework shows how to collect, analyze, and use data to meet the needs of learners on choosing courses. In order to recommend personalized courses, the ERS should collect data of learners and courses from multiple sources of a university and analyze the data using AI-based algorithms such as content-based recommendation algorithm, collaborative filtering-based recommendation algorithm, and recommendation algorithm with the knowledge graph. The ERS should allow learners to search for courses and provide a personalized recommendation of courses based on their competencies, interest, career plan, and curriculum.

This study created five ERS design principles. First, educational data should be safely and efficiently collected and managed in the ERS (e.g., data dam, data pipeline). Second, the recommendation results should be explained so that learners have autonomy in making a decision. Third,

the ERS should help learners to develop their competencies in a balanced way through increasing serendipity in recommendation results. Fourth, the ERS should be designed based on learners' experience of exploring, selecting, and registering for courses. Lastly, education experts should participate in the ERS development process, and the ERS should be revised iteratively based on learners' feedback. These principles are necessary for developing a recommendation system that is educationally helpful for learners.
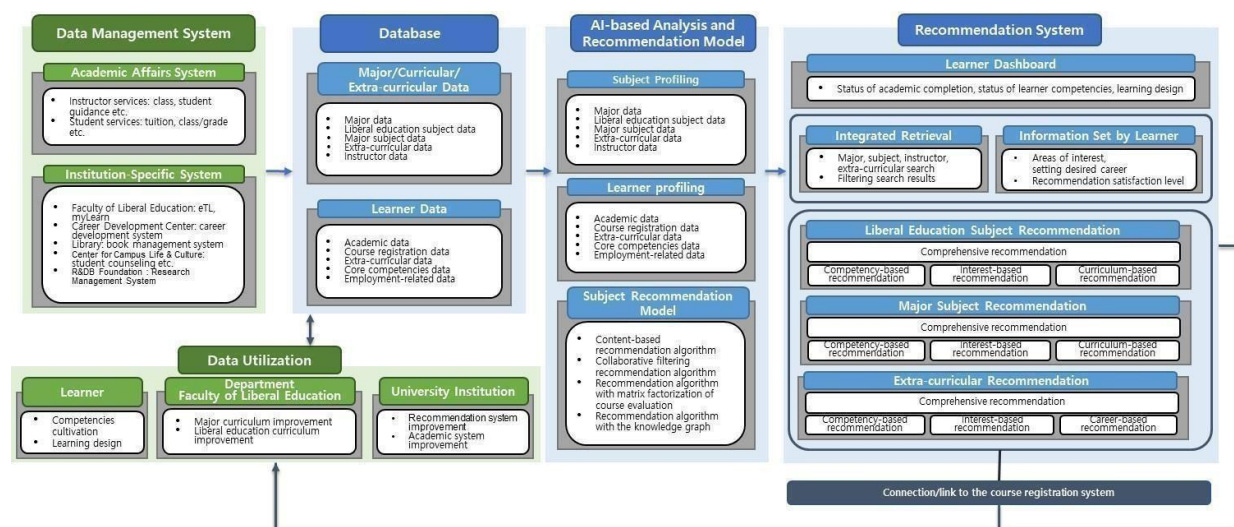

Figure 1. Educational Recommendation System Framework

5. Conclusion

The ERS can contribute to increasing learners' satisfaction with higher education and improving their competencies that are necessary for the future society. Educators should collaborate with computer scientists and data scientists to overcome the problem of filter bubbles and to develop educationally desirable recommendation systems.

This study has a limitation in validating the ERS design principles. Future research is necessary to develop the ERS based on the design principles and iteratively revise them through receiving feedback from learners. Particularly, it is necessary to investigate how to recommend courses based on learners' competencies, which are crucial in education but difficult to assess.

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