Intelligent Agent-Based e-Learning System for Adaptive Learning

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ABSTRACT

Adaptive learning approaches support learners to achieve the intended learning outcomes through a personalized way. Previous studies mistakenly treat adaptive e-Learning as personalizing the presentation style of the learning materials, which is not completely correct. The main idea of adaptive learning is to personalize the earning content in a way that can cope with individual differences in aptitude. In this study, an adaptive learning model is designed based on the Aptitude-Treatment Interaction theory and Constructive Alignment Model. The model aims at improving students’ learning outcomes through enhancing their intrinsic motivation to learn. This model is operationalized with a multi-agent framework and is validated under a controlled laboratory setting. The result is quite promising. The individual differences of students, especially in the experimental group, have been narrowed significantly. Students who have difficulties in learning show significant improvement after the test. However, the longitudinal effect of this model is not tested in this study and will be studied in the future.

Keywords: Adaptive Learning, Aptitude Treatment Interaction (ATI), Constructive Alignment, e-Learning, Intelligent Agent, Multi-Agent

1. INTRODUCTION

Individuals learn differently. The concept of adaptive learning is used to cope with individual differences in aptitude. It is assumed that adaptive learning can support individuals to achieve the designated learning outcome by picking the most suitable means. Adaptive learning in fact is not new to the fields of education and information systems. However, most adaptive e-Learning research focuses on applying the available technologies to personalize the presentation style of learning materials. Only few of them have mentioned personalizing learning content to cope with individual differences in aptitude, but without a theoretical foundation.

Aptitude Treatment Interaction (ATI) theory states that if choice of the instruction methods is best matched with the aptitude of individual learner, the probability of having
ideal learning outcome will be higher. Aptitude is a quite consistent pattern and may take a long time to change or even cannot be changed while treatment (i.e. instruction method) can be changed.

Snow (1989) suggests that learners who have poor aptitude require a highly structured learning environment or learning content to support their learning. The ATI theory has not been operationalized in previous studies because of the difficulties in evaluating aptitude and matching appropriate instruction method. The ATI theory itself does not provide help in this aspect while Biggs’ Constructive Alignment Model may help. Biggs’ model is a curriculum design model that addresses the alignments between related items in a curriculum (e.g. teaching and learning activities, learning content and assessment tasks) (Biggs, 2003). Assessment tasks are used to evaluate the level of attainment of learners and can be applied to test whether the learner is capable to advance to the next level of study. If not, highly structured learning content should be provided before advancing to the next level to avoid frustration.

Based on the ATI theory and the constructive alignment model, an adaptive learning model is developed in this study. This model is targeted at enhancing students’ learning outcomes by means of strengthening their intrinsic motivation to learn. The logic to operate this model is complicated as the needs vary between individual learners. As such, multi-agent architecture is chosen to operationalize the model. Multi-agent architecture is designed to solve complicated problem which cannot be handled by one single agent while no other technologies can perform better than multi-agent one.

A short curriculum called Introduction to Hang Seng Index has been constructed by two experienced teachers in this discipline, based on Biggs’ Constructive Alignment framework. Biggs’ framework was referenced because this alignment mechanism concerns the matching between the course objectives and course contents. This framework also suggests that assessment task is a good tool to test the level of development of students. Before advancing to the next level, teachers have to make sure the students have no fundamental problem in the current level with assessment task(s). These characteristic makes this framework a good choice to work as the operation blueprint of the ATI theory. Based on the current aptitude level (or level of development of individual students), the adaptive e-Learning system is able to provide adaptive support without human intervention.

A controlled experiment was conducted, in which 81 undergraduate students who study in the College of Business of one Hong Kong university joined voluntarily. They were randomly assigned to either the experimental group or the control group. Adaptive features were only provided to the experimental group. Each student has spent at most 1.5 hours to go through the curriculum under a controlled laboratory setting, while discussions were prohibited throughout the study. Debriefing was provided after the experiment. Certain individual differences variables, such as gender, age, education level, and preference in presentation mode are well controlled. The pre-test and post-test data were collected both quantitatively and qualitatively. The results showed that students who did badly in the assessment tasks and had received the adaptive support can benefit the most.

2. LITERATURE REVIEW

People learn differently is absolutely not a new idea (Fizzell, 1984). Keefe (1979) defined individual differences in learning as a consistent pattern of behaviors that an individual approaches educational experiences. It is a relatively stable indicator of how a learner perceives, interacts with, and responds to the learning environment. Conversely, adaptive course design may further enhance learning.

In this section, educational theories related to adaptive learning are described. The emphasis of adaptive e-Learning system is to realize pedagogy with the support of an electronic platform, rather than simply being used as data repository (Hiltz et al., 1999). As such, the reasons why intelligent agent technology is
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