The Innovative Application of Learning Companions in Chronicles of Singapura

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ABSTRACT
The Chronicles of Singapura (CoS) is a learning companion augmented virtual world designed for lower secondary school students to learn the transport systems in plants. Two types of learning companions, (1) the curious companion and (2) the remembrance companion, have been incorporated. Up to date, CoS has been deployed in two local secondary schools in Singapore and involved over 500 students in its studies. To our best knowledge, this is the first work to investigate a learning companion augmented virtual world as a learning environment in such a large scale. Results collected from the field studies have demonstrated the advantages of this type of systems in enhancing students’ learning experiences.

Categories and Subject Descriptors
H.4 [Information Systems Applications]: Miscellaneous

General Terms
Design, Human Factors

Keywords
Learning Companions, Virtual Worlds, Curious Agent, Remembrance Agent

1. INTRODUCTION
The virtual worlds offer an advanced “hard” infrastructure to simulate learning environments that can be impossible to access in real world. However, a stand alone virtual world lacks “soft” intelligence to monitor and scaffold the students in real time during the learning process. Many studies have shown the advantages of using intelligent software agents to achieve educational goals in computer-based learning environment [1]. We believe, the infusion of various light weight learning companions, each with a specific educational goal, has the potential to enhance immersion by realizing interactions that can be challenging or expensive to achieve in real world. For example, a personalized mentor to monitor the student during her learning process and provide situational assistance; or a private learning companion who can study with the student and provide a social learning environment.

During the past five years, we has been continuously developing a learning companion augmented virtual world - the Chronicles of Singapura (CoS) 1, which is designed for lower secondary school students in Singapore to learn the transport systems in plants. In order to scaffold students’ learning to improve their learning motivations, till date, two types of intelligent learning companions have been incorporated into the CoS. They are the curious companion and the remembrance companion. The curious companion is designed to cope with the problem in virtual world based learning environment where the students tend to be attracted by the visual and auditorial stimuli and be distracted from the learning objectives [2]. The curious companion can select potentially interesting learning concepts for the students to focus their attention in the learning content when distraction is detected. The remembrance companion is designed to reduce students’ cognitive load, which can assist the learner to organize their knowledge and help them connecting new situations with previously acquired knowledge.

CoS has been deployed in two local secondary schools in Singapore and involved over 500 students to participate in the study. To our best knowledge, this is the first work on a large scale deployment of a learning companion augmented virtual world in schools. The results from the field studies have demonstrated the advantages of such a system to enhance students’ learning experiences.

2. CURIOUS COMPANION MODEL
The curious companion perceives three sources of information: the world knowledge WK, the user’s current knowledge UK, and the user’s context UC. WK is predefined and represented by a Concept Map (CM), which is embedded in the virtual world as part of the virtual objects and learning tasks. UK is also represented by a CM, which is updated in real time by the users through a GUI. UC contains information about the user’s behavior, such as current goal, current interaction, etc. The curious companion performs two functions: distraction detection and curious reasoning. The distraction detection module continuously monitors the UC, and once distraction is detected, it will perform curious reasoning to calculate the intensity of curiosity stimulating factors in learning concepts based on the comparison between WK and UK. Based on the ranking of curiosity value, it can select the potentially most interesting learning concept to engage their attention in learning. The Curious Companion in CoS is shown in Figure 1(a).

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1http://virtualsingapura.com/game/project/
The remembrance companion also perceives three sources of information: WK, UK, and UC. The agent proactively monitors the user’s behavior in UC. When the user is detected as being stuck, the agent will retrieve the most relevant concepts to help the user solve the problems. UK represents individual user’s learning behaviors which is collected through the user interactions with various learning concepts. Such behaviors are first stored in the agent’s episodic memory (EM), which are further consolidated into the agent’s semantic memory (SM). The consolidation is solved as a multi-label episode classification problem, in which each concept in WK is considered as a class label. When the player is detected as being stuck (e.g. the player is stuck at answering questions, asking for help, or spending long time to solving a problem) in UC, the agent will extract relevant episodes in the EM or learning concepts in the SM, and present them to the user in a non-intrusive manner. The Remembrance Companion in CoS is shown in Figure 1(b).

4. EVALUATION

In this section, we will present the results of one of the studies in the Catholic High School. A total of 63 Secondary Two level (equivalent to Grade 8 in the North American high school system) students who are rated as having average academic abilities by their teachers, were selected to participate in the study. The topic was transport systems in plants, which was chosen from their science class curriculum. Before the study, both groups have not learnt the chosen topic at the secondary school level (but they did encounter this topic during their primary school years).

The study includes 3 sessions, one for the students to draw concept maps of plant related knowledge points on their own, and two separate sessions of 45 minutes each in which the students go through all the learning activities in the CoS. During the study, one group studied the topic through CoS, and the control group studied the topic with the stand alone virtual world without the learning companions. After these sessions, the students completed a survey questionnaire consisting 28 questions on the scale of 1 (strongly disagree) to 7 (strongly agree) assessing various aspects of the system.

We performed statistical test for the survey results with respect to the two learning companions. The first hypothesis is that the curious companion can retain the students’ attention in the learning content. The T-test result accepted our hypothesis with a significant difference (T=2.786, p=0.05). The group of students with the help of curious companion (M=5.6, SD=1.32) concentrated more on the learning content than the group without the help of the curious companion (M=4.45, SD=1.87). The second hypothesis is that the remembrance companion can assist the students to retrieve their knowledge. The T-test result also accepted our hypothesis with a significant difference (T=2.633, p=0.05). The group of students with the help of remembrance companion (M=4.69, SD=1.76) achieved higher efficiency in learning tasks than the group without the help of the remembrance companion (M=3.43, SD=2.01).

5. SUMMARY AND FUTURE WORK

This paper reported on CoS, a learning companions augmented virtual world designed for lower secondary school students to learn plant transport systems in Singapore. The key innovation of the CoS project is the infusion of two types of learning companions: curious companion and remembrance companion. CoS has received positive responses from the students and teachers in local secondary schools in Singapore. In the future, we plan to incorporate more types of light weight learning companions into the virtual world for achieving more educational goals. Also, the large scale deployment of our system offers a good opportunity to collect huge number of user data in educational settings, which enables the possibility of educational data mining.

6. REFERENCES
