A Conceptual Framework for a Smart Learning Engine

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Abstract. Learning activities and environments have changed dramatically in the last 50 years, in large part due to information and communications technologies. New technologies make it possible to create a smart learning engine in the form of an intelligent personalized learning system that can be integrated with a variety of interaction devices. In addition, on the instructional design and personalization/customization side of things, a smart learning environment can structure or recommend specific interactions for individual learners based on subject matter, learning goals and a learner's preferences, interests, ability, and knowledge. This means that a smart learning environment can develop meaningful learning pathways for individual learners and create optimal learning activities to help learners attain intended goals by deploying suitable learning resources and interactive tools to enhance learning, performance, and the student's experience.

Keywords Leaning environment; Smart learning; Intelligent tutoring system

1 Introduction

Smart learning environments (SLEs) herein are defined as active learning places that can be used to access and structure learning content, sense specific learning contexts and goals, identify a particular learner's abilities and needs, provide relevant learning resources and interactive tools, automatically record learning process and evaluate learning accomplishments so as to promote efficient learning [1]. This is an ambitious list of capabilities, but individual parts of such an

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environment have already been created and demonstrated. An integrated, interactive and intelligent (i^3) system has yet to be fully developed and deployed, but that is the goal of the effort reported herein. In the 21st century, new learning systems are being developed at an increasing pace to take advantage of powerful new technologies, such as the JuxtaLearn system (ClipIt) [2]. Many more powerful new learning technologies and environments could be mentioned, but they introduce a new challenge for teachers – namely, the challenge of identifying the appropriate tools or technology to use with specific learners in a variety of learning situations. The teacher task is becoming increasing more difficult as these systems proliferate.

In response to this challenge, we propose an i^3 (integrated, interactive, intelligent) system that can support both students and teachers amid the technology challenges of the 21st century. In this paper, a Smart Learning Engine (SLEng) is proposed as the core of an i^3 SLE. We propose a theoretically-grounded and empirically informed conceptual framework that features an intelligent personalized learning system for the improvement of teachers and learners by integrating different systems together and providing services for different learning scenarios and content.

2 Relevant Research

One could argue that the first SLE and associated education engine was the Programmed Logic for Automatic Teaching Operations (PLATO) created at the University of Illinois. PLATO was the first computer-based education system and the home of the first online learning community (albeit through networked learning labs and local area networks initially). PLATO provided a means for individualized student instruction and opened the door for interactive computer education. Online education would not be where it is today without the development of PLATO [3].

ITSs (Intelligent Tutoring Systems), also called cognitive tutors, were developed to guide learners through a learning process [4]. These systems can be used in the traditional educational settings or in distant learning courses, either operating on stand-alone computer or as applications that deliver knowledge through the Internet. An ITS can provide adaptive support for student problem solving or question answering activities in a variety of well-structured domains. Sleeman and Brown reviewed the state of the art in computer-aided instruction and first coined the term 'ITS' to describe these evolving systems and distinguish them from the previous CAI systems [3]. ITS research has successfully delivered techniques and systems that provide adaptive support for student to improve problem solving abilities in domains that are well-structured with clearly defined problems and learning outcomes.

While an ITS typically had an extensive bug library (database of common misconceptions and errors), there was no way to extend that library or build on the experience of learners in responding to various forms of automated remediation. Moreover, learners have a variety of predispositions, interests and moods, and they are influenced by external factors such as prior knowledge, types of tasks, and facilitation; these factors can affect their learning progress [5]. In response to that shortcoming, a SLE should not only be integrated and interactive, it should be intelligent and improve its performance over time based on how large numbers of learners are doing in various learning situations. As a result, learning analytics can be used to recommend activities and resources based on how similar learners similarly situated have performed when using those resources and engaging in those activities [6]. The SLEng proposed herein contains the ability to improve over time based on learning analytics, which means that it will be able to support an i^3 SLE.

3 Components of the Conceptual Framework

The SLEng has some similarities with an ITS; both of them can track students' learning, tailor personalized feedback, or suggest teaching strategies for fitting learning and teaching needs. The SLEng described herein can integrate different educational systems, resources, tools and delivery mechanisms, improve in performance based on the experiences of prior learners using those resources, and can consider the learner in a more holistic manner, including interests, preferences, predispositions as well as prior knowledge and ability. The SLEng consists of three main functions: (a) I - identifying relevant data about the subject, the environment and the user, (b) C - computing an appropriate learning pathway, and (c) D - deploying suitable resources for students and the teacher. The SLEng will make use of prior research and theory to create engaging, effective and efficient learning experiences (e3 learning). Three main functions are descripted as follows.

Identifying (I component). The main concept of the I component is to identify data from student, teacher, subject area, and the environment using wireless sensors, the established learning resources and scenarios, and a learner modeling technology. The acquired data includes learned prior knowledge, theme-based knowledge and aspects of the physical learning environment which then inform the C and D components.

Computing (C component). By identifying learner's characteristics, study status and study situation will then compute an optimal learning process, a learning pathway, and also predict student's action. The C component can compute which kind of resources the learner will need and calculate an appropriate way of learning. Therefore, based on the results of identifying component, the C component of SLEng could model users' affective data, build complete structure for descripting each domain knowledge, optimize the knowledge module for adapting the individuals, and connecting between users' data from learning community.

Deploying (D component). According to common misconceptions and individual needs of students and teachers, the D component will automatically deploy the most suitable strategy, resources and tools for students and teachers. In order to stimulate students' learning enthusiasm, let them have a higher learning incentives and learning effectives through SLEng, deploy appropriate resources is indispensable. Therefore, the main ideal of the D component is to accord the users' personal features to deliver the personalized and adaptive supports for students as well as teachers.

4 Implementation and Evaluation Plans

The overall goal of the SLEng is to improve learning and teaching, especially in K-12 settings. As this is a conceptual framework, the next step of the implementation plan is to develop a prototype based on a SLEng containing **ICD** components to verify whether we can build such comprehensive system and whether we can integrate various technologies effectively in a single system. The second stage is to evaluate the implemented prototype by conducting the feasibility studies on the I, C and D components of this prototype and then optimize the prototype based on the data from investing the people who use the prototype system. Each feasibility study will inform subsequent feasibility and usability studies. However, since the SLEng proposed in this study is still in early stage of development, more system stability is anticipated to better facilitate their learning.

This system is being tested in a laboratory setting using representative teachers from a number of primary and secondary schools. The initial test domain is Learning English as a Second Language as this subject is emphasized and lends itself to personalized learning quite well. The second test domain is likely to be mathematics so as to test the i^3 system with a totally different subject matter. On the output side, some of the components are already being tested in school settings. The evaluation will include obvious measures such as learning outcomes and student performance as well as sustainability measures such as teachers' abilities to modify and customize resources and activities using tools integrated within the system.

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