Paradigm and Architecture of Computing Augmented Learning Management System for Computer Science Education

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ABSTRACT

Literature suggests that existing learning management systems should be extended to integrate learning activities that aim at enhancing comprehension of students in Computer Science education. Therefore, literature has proposed Computing Augmented Learning Management System (CALMS) that meets the needs of online Computer Science education. However, it's unclear the current state of architecture for the CALMS to assist researchers interrogate and extend its modules for online Computer Science education. Pedagogically to ascertain the thinking direction of current Computer Science educators it's also relevant to understand philosophical stance of learning events from the new idea of CALMS for online computer science education. The review reveals that learning events of the CALMS suggest an adaption of moderate constructivism stance for online Computer Science education. The CALMS incorporate annotations, algorithm or animation visualization and automatic assessment for the purposes of computer science education.

KEYWORDS

Architecture, CALMS, Computer Science Education, Computing Augmented Learning Management System, Learning Management System, LMS, Online Learning, Pedagogy

INTRODUCTION

Online Computer Science education relies on learning management systems for teaching and engaging students in distance. However, regardless of the teaching and learning platform, programming languages are perceived as one of the central concepts for computer science education (Zendler, 2008). Nevertheless, programming courses in particular, need full range of interaction, visualization and collaborative learning media to meet the needs of novice programmers (Thota et al., 2009). Unfortunately, stimulating interaction and algorithm or animation visualization with current learning management system create a challenging task for Computer Science education (Thota et al., 2009). Therefore, to customize the course environment to meet the learning needs of novice programmers and enable the integration of specialized Computer Science education tools necessitated the idea of a Computing Augmented Learning Management System (CALMS) (Thota et al., 2009; Rößling et al., 2008). According to the ITiCSE 2008 working group, CALMS is a standard that can be customized by educators to meet their needs by integrating Computer Science content with plug-in modules of learning systems developed by themselves or others (Robling et al., 2008). In other words, CALMS are LMS designed specifically for Computer Science education (Brusilovsky et al., 2014).

Setting up scope for the CALMS, Robling et al (2008) point out that the aforementioned system ought to provide ability to integrate dynamic visualizations and simulations of algorithms and data

structures, automatic functional assessment, support students code experiments, group work and specific subareas of Computer Science such as formal languages, modeling or simulations. Most especially the automatic assessment system proposed for CALMS seeks to increase efficiency of computing educators and attend to large class sizes in developing countries.

The aforementioned scope for CALMS patronizes certain theory of thinking and learning activities that depart from the traditional constructivism ways of acquiring knowledge and skills in Computer Science education. An interrogation into epistemological bases of CALMS stands to highlight underlying philosophical paradigm of computing educators towards online studies in Computer Science education. The implication of a philosophical paradigm from CALMS shed light on current theory of thinking of computing educators towards the debate between objectivism and constructivism. The extent of departure of computing educators' choice of learning activities from constructivism stand point towards adaptation of aspects of objectivism would suggest whether epistemological bases of CALMS are rooted in radical or moderate constructivism for online Computer Science education. Similarly, the architecture for CALMS seeks to highlight conceptualization of its current state and extendable option to existing Learning Management Systems (LMS).

BACKGROUND

There are several inspiring studies towards the realization of general objectives in institutionalizing the CALMS for Computer Science education. Basically, the CALMS aims at providing annotation of learning materials, algorithms or animation visualization and automatic programming assessment for computing educators and students (Robling et al., 2008a). Thota (2009) used LMS with plug-in modules that aim at introductory programming course design which includes learning theories, instructional process and learning taxonomies. The researcher reported on improved learning and teaching for the Computer Science education. Furthermore, Robling et al. (2009) in their paper entitled "Extending Moodle to Better Support Computing Education" presented activities that added annotation of materials such as scripts, inclusion of slides and integration of algorithm visualizations to Moodle. Similarly, Robling et al. (2008) looked at the possibility of enhancing LMS to better support computer science education. The researchers' principles concentrated on building CALMS. The researchers observed that some Computer Science specific resources identified for the CAMLS were seldom open source. Similarly, Robling et al. (2010) in their paper entitled "Adopting Moodle to Better Support Computer Science Education" revealed that Moodle do not yet provide adequate support for domain specific activities such as automatic code management, automatic assessment and visualizations.

Nevertheless, literature still needs to increase conceptualization of current state in CALMS with an architecture and assesses its completeness as well as understand the philosophical paradigm its online course environment brings to bear on constructivism tradition in Computer Science education. This study engages in discourses of philosophical stance, current state of the art and available automatic assessment options to enhance the idea of CALMS for Computer Science education.

Research Methods

According to Mulrow (1994), systematic literature review is regarded as one of the fundamental scientific activities that reduce large quantities of information into manageable form for digestion. The review systemically analyse scientific publications regarding the idea of CALMS for Computer Science education between 2008 and 2016. The searching time period was set from 2008 because the researcher believes that the idea for CALMS was muted in 2008 for Computer Science education.

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