Self-Regulation Strategies and Technologies for Adaptive Learning Management Systems for Web-based Instruction

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Abstract:

The current study identify the potential problems of current web-based instruction and learning management systems in terms of its lack of flexibility and customization required for individual learners' different goals, backgrounds, knowledge levels, and learning capabilities. Advanced adaptive learning management system technologies are able to give possible solutions and mechanisms for adaptively foreseeing, monitoring, organization, and evaluating individual learners within learning management systems. According to Brusilovsky and Vassileva (2003)'s suggestions, the authors are introducing the examples of adaptive system mechanisms for adaptive self-regulation can be such as Glossary, Indexed Textbooks, Advanced Navigation, Direct Guidance and Adaptive Navigation Support, Adaptive Guidance for Prerequisite-based Help, for large scale of web-based learning management systems.

Introduction

A lot of organizations, nowadays, implement Learning Management Systems (LMS) or Learning Content Management System (LCMS) to manage, track, and quantify all of learning activities and resources in an institution to meet the individual and organizational needs as one of the effective advanced learning technology. There are some of well-known learning management systems particularly developed for university such as WebCT (Goldberg, Salari & Swoboda, 1996), Virtual-U (Harasim, Calvert & Groenboer, 1997), FLAX (Routn, Graves & Ryan, 1997), TopClass (WBT Systems, 1997) and Learning Space (Lotus, 1997). They are also commercially available for corporate and government settings as well. Some organizations, moreover, invest fortunes to build their own LMS/LCMS since they realize the inevitable needs of managing, reusing, and utilizing their valuable electronic assets including knowledge, information, and resources.

Is LMS/LCMS valuable enough for organizations to invest considerable budget for it? LMS/LCMS can be defined as electronic management systems, which enable to design, review, converse, store, maintain, analyze, and upgrade electronic content. There can be more creative processes of dealing with electronic content depending on the users requests. Then, what is electronic content? The formats and modes of electronic content can have various shapes and modes. It can be web pages having various elements such as text, graphics, controls, multimedia, and etc. At the same time, it can be various applications, database, various types of files, programming logic or naming conventions.

In order to make the electronic assets available for being used for authentic problem solving, the learners should go through a series of complicated processes within LMS/LCMS. When we think about the whole process and resources of LMS/LCMS in terms of human learning and performance aspects, it involves complicated steps of incorporating the abundant resources into authentic problem solving. That is to say, the learners need the techniques and strategies to use them uniquely for their knowledge construction, task completion, and performance improvement. Otherwise, the fortunes of investment for LMS/LCMS cannot give the expected return on investment for their organization. Learners are likely to face with potential problems of managing the breadth and depth of electronic resources, driving them as they planned, incorporating them into their performance, and optimizing them for their workplace.

Current Learning Management Systems

The adaptive features of LMS/LCMS become more necessary since the learners visit their LMS/LCMS to meet their own unique needs based on their current readiness. Individual learners have their own experience, knowledge and skills, as well as cognitive abilities, personality traits, learning styles, interests, and motivation before they approach the electronic contents in LMS/LCMS. The main difficulties of learning management systems

come from the variety of course forms and resources. Students have various learning sources such as lectures, tutorials, examples, quizzes, and assignment, which are not likely to be organized nor managed to serve individual learner performance efficiently. Moreover, in many current Web-based courses, the course material is still predominantly oriented for traditional on-campus audiences who have a lot of similar demographic characteristics. Web-based courses, however, are to be used by much wider variety of learners than any campus-based courses. These learners may have very different goals, backgrounds, knowledge levels, and learning capabilities. The only way to enhance it is to make the course material richer and more flexible so that different students can get personalized content and a personalized order of presentation.

Adaptive features should be one of the main functions of LMS/LCMS to enhance learning and performance of its target audiences. The systems are required to be more adaptive to individuals so that they can really meet the learners' unique needs just on time. Current Web-based courses in this respect are not "supportive". Neither the teacher nor the delivery system can adapt the course presentation to different students. Some students waste of their time learning irrelevant or already known material, and some students fail to understand (just misunderstand) the material and consequently overload a distance teacher with multiple questions and requests for additional information. Here we can see the needs of adaptive Learning Management Systems for Web-based instruction.

The rapid progresses of web and computer programming technology have enabled the Web-based adaptive functions but the functions have not been delicately designed in the manners how users effectively learn, manage, incorporate all the overwhelming electronic contents into their authentic environment. Even though TopClass is capable of annotating (Bursilovsky et al., 1998), they do not fully satisfy with providing domain structure, which indicates the location of current pages and relationship with other pages. Therefore, the needs of implementing adaptive features to self-regulate their process of using LMS/LCMS will raise up the current LMS/LCMS to the next level. Then, what kinds of adaptive features and functions will be the most important for the users of LMS/LCMS? In this paper, we would like to particularly suggest the adaptive features for automated self-regulation support. The adaptive self-regulation features can support and guide users to plan, manage, monitor, and evaluate the whole process of implementing LMS/LCMS to meet their customized needs. The following sections will introduce the possible self-regulation strategies for planning, managing, monitoring, and evaluating electronic resources, which can be incorporated for effective design of adaptive LMS/LCMS.

Self-regulation Strategy for Adaptive Learning Management Systems

In order to solve the potential problems in customizing the web-based learning management systems and to meet the different individual needs, the self-regulation strategies and its adaptive system technology might be effectively implemented as the problem. Self-regulated learning is an important aspect of student academic performance and achievement especially in online learning settings, which lack the physical face-to-face interactions with instructor and other students. Self-regulation can be broadly defined as the efforts by students to monitor, manipulate, and improve their own learning (Corno & Mandinach, 1983). Self-regulation includes factors such as resource management, goal setting, success expectations, and deep cognitive involvement (Trawick & Corno, 1995). Self-awareness, self-monitoring, and self-evaluation are major issue for successful self-regulation strategies (McCombs, 1989). Social cognitive theory, being rooted in Bandura's theory, has been successfully used to explain the function of self-regulation in academic settings (Bembenutty, & Karabenick, 2004). According to social cognitive theory, successful students are those who actively engage in self-regulation of their motivation, cognition, environment, and behavior (Zimmerman, 2000). Although there are many ways to define and to articulate learning strategies and processes for self-regulation, all have a commonality of basic assumptions that self-regulation is a proactive learning process systemically using metacognitive, cognitive, and motivational strategies to achieve academic goals and performance with the interaction of environmental conditions. With self-regulation mechanism, expert learners are able to identify the type of tasks and goals, the amount of efforts and time to achieve them, and the type of resources and contents to use for accomplishing learning goals.

Based upon the theoretical grounds, this study defines the critical features of successful self-regulated learning such as foreseeing, managing, monitoring and evaluating. When an individual interacts something from external environments, he or she foresees what will happen. In academic learning settings, learners' foreseeing on learning tasks and contexts can initiate cognitive and motivational interests. Managing is a process to control external learning environments (e.g. time, social interaction and help seeking) and internal cognitive processing. This feature concerns with setting one's own learning goal, making a plan to achieve the learning goal, and managing learning resources and tools. Monitoring is the process where learners check out, aware of and think about their own learning processes according to the learning goals. Through the monitoring process, learners take responsibilities for the achievement of learning goals, and the construction of personal meaning. Evaluating is a process to assess learning processes and outcomes for completing entire work. It involves with comparing learning performance based on the

predetermined learning goals, and to modify learning strategies, if needed. In actual learning circumstances these features are inseparable from and intimately connected to each other. When some approaches to enable these features of self-regulation are embedded in learning management system, less self-regulated learners can learn how to self-regulate learning process and manage vast amount of learning contents based on the adaptive self-regulation features. Even more self-regulated learners can actively manage their learning progress and learning resources more effectively based on adaptive learning management system features.

Ley and Young (2001) also suggest four main principles to embody both effective and flexible guidance for self-regulation into instruction as follows: a) guide learners to prepare and structure an effective learning environment; b) organize instruction and activities to facilitate cognitive and metacognitive processes; c) use instructional goals and feedback to present student monitoring opportunities; and d) provide learners with continuous evaluation information and occasions for self-evaluation. Niemi, Nevgi and Virtanen (2003) have developed the interactive web-based tool to support learners' self-regulation in web-based higher education settings. The tool consists of three elements: the interactive test bank, tutoring sets, and learning diary.

In this study, the four main principles are considered for embed self-regulation support strategies in learning management systems as follows:

Individual Preference and Self-control Diagnosis Individual preference and self-control diagnosis builds varied and multiple representation of domain knowledge. Multiple representation of knowledge can help learners to interpret the knowledge and incorporate it into existing models. Learners interpret the given tasks and environments with their different experiences and their existing mental models. According to this view, varied knowledge should be provided so that learners can access it with their preference and control.

Cognitive and Volitional Progress Tracking Cognitive and volitional progress tracking track learner's cognitive and volitional progress for instructional supports. Individual learners' experience, such as readiness, interests, concerns, feelings, and knowledge expressed from individual learners throughout the whole learning process, is a critical basis for learners to aware their progress and for teachers to give them with adaptive instructional supports.

Directive Self-Regulation Guide Directive self-regulation guide empowers learners to direct their learning throughout individual and social learning process. Learning environments should provide opportunities and conditions to enable learners to self-regulate their learning processes by: a) setting their personal goals; b) planning learning activities; c) structuring learning situations; d) selecting resources and learning strategies; e) evaluating learning processes and products by themselves; f) revising the processes and g) transferring obtained knowledge to the new situations. Through these regulating processes, learners can have successful academic achievement and greater responsibility for their learning.

Self-awareness and Self-assessment Self-awareness and self-assessment encourage self-awareness and self-assessment for the learning process. Learning environments should provide learners with opportunities to review and appraise learning activities and learning outcomes by themselves throughout the whole learning process.

Adaptive Web-based Learning Management System Technology for Effective Self-regulation

In order to actualize self-regulation strategy in the web-based learning environment, adaptive components of computer technologies should be implemented. The systems should have both the domain model and the student model. The domain model will have the general data bank regarding resources and materials such as topics, knowledge elements, objects, and learning outcomes. Meanwhile an individual student's knowledge model stores some value, which is an estimation of the student knowledge level of this concept. This type of model is powerful and flexible: it can independently measure the student's knowledge of different topics. The overlay student model can be updated frequently.

All student actions (the frequency and pattern of visits, the level of problem–solving, the quantity and quality of participation) are tracked and used to increase or decrease knowledge levels for involved concepts. Another important component of the student model is the model of student's learning goals. A sequence of assigned learned goals forms an individual order of learning. Adaptive guidance technique will provide adequate information for step-by-step sequence and progress based on the comparison between domain model and individual model information.

Brusilovsky and Vassileva (2003) suggest the adaptive web-based learning mechanisms for large scale web-based education which can potentially be implemented for adaptive learning management systems in terms of the glossary, indexed textbooks, advanced navigation, direct guidance and adaptive navigation support, and adaptive

guidance for pre-requisite based help. These adaptive mechanisms can be alternatively implemented for self-regulation strategies of guiding, monitoring, organizing, and evaluating individual learners study and learning as an important part of learning management systems.

The glossary According to Brusilovsky and Vassileva (2003), glossary is considered as a visualized network for various domain of knowledge. Each node of domain knowledge is connected to each other within the glossary. The links between domain model concepts consist navigation paths between glossary entries. This glossary function can effectively used for monitoring particular learner's progress of study as well as particular domain of knowledge and skills that she/he has been studying. This can provide guidance for further study or pre-requisite study of particular learners.

Indexed textbooks Indexed textbooks are likely to help tracking the current learning progress and schedules. One of the biggest problems in web-based learning for large scale of contents and learners is that individual learners can have hard time to follow up the consistent study progress due to the lack of monitoring function. However, if the indexed textbook function monitors the detailed individual study progress, learners do not need to be intimidated by a lot of learning contents. They will be able to catch up with the previous learning progress consistently.

Advanced navigation Advanced navigation has the functions of holding the knowledge about the domain and about the textbook content to serve a well-structured hyperspace. According to Brusilovsky and Vassileva (2003), this system provides all regular navigation tools: sequential and hierarchical links within unit hierarchy. At the same time, it provides the navigation center for one-click transfer to all sections on the same or upper levels as well as generates a table of contents where all entries are clickable links to the particular content. This function will be able to support learners to organize complex learning hierarchy as well as the breadth of learning contents without redundant steps.

Adaptive annotation and direct guidance According to Brusilovsky and Vassileva (2003), to support the student navigating through the course, the adaptive system have adaptive annotation and direct guidance technologies. Adaptive annotation means that they system uses visual cues (icons, fonts, colors) to show the type and the educational state of each link. Direct guidance means that the system can suggest to the student the next part of the material to be learned. This function is the highlight of adaptive system to support guiding of self-regulation strategy in the adaptive learning management systems.

Adaptive guidance for pre-requisite-based help This is problem-driven approach rather than goal-driven. Therefore, the evaluating steps are embedded behind the function. The system's knowledge about the course material comprises knowledge about what the pre-requisite concepts are for any unit of the textbook. At the same time, the current level of knowledge and skills of learners should be evaluated before giving adaptive guidance. When students have problems with understanding some explanation or example or solving a problem. In that case they can prerequisite-based help (using a special button), and the system generates a list of link to all sections that present some information about background concepts of the current section. Adaptive guidance provides significant assistance for novices while adaptive navigation support provides significant assistance for more experienced learners (Brusilovsky and Vassileva, 2003).

Personal construction on learning process This system provides with an individual space where learners can cumulate and reconstruct inputs and outputs obtained throughout the learning processes by themselves. That is, this function is to save every information and data that learners build up, to organize those by the pre-set criteria, and to allow learners retrieving and reconstructing at anytime. Various tools, such as communication tools, process tools should be included to support learners' activities. Adaptive Web-based LMS features based on adaptive technology discussed above can highlight some of their features based on self-regulation principles and strategy as follows in table 1

Self-Regulation Principles	**Self-Regulation Strategy**	**Adaptive Technology**	**Adaptive Web-based LMS Features**
Individual Preference and Self-control	• Interpretation of individuals' existing knowledge and experience	• The Glossary • Indexed textbooks	• Pre-diagnosis of the current users' knowledge and experience • Analysis of the user

Diagnosis	• Learner identification of their preferences and level of self-control • Diagnosis of individual differences in terms of readiness, interests, concerns, feelings, and knowledge • Multiple representation of domain knowledge	• Advanced navigation	characteristics in terms of subject matter interest and needs • Self-diagnosis for users' volitional control and self-regulation status • Automated user analysis report • System suggestion and advice for user's goal setting and planning • Visualized network presentation for various domain knowledge relevant to users current needs
Cognitive and Volitional Progress Tracking	• Individual tracking for learner's cognitive and volitional progress for instructional supports. • Progress checking throughout the whole learning process • Adaptive instructional support based on the individual progress	• Advanced navigation • Adaptive annotation and direct guidance	• Individual performance gap report between current learning status and the pre-planned status • Individual learning progress and current status report for each subject matters or course • System suggestion and advice based on users' current learning management and performance status
Directive Self-Regulation Guide	• Direction for individual self-regulation strategy • Practice provision for self-regulation • Personal goal setting • Learning objective planning • Learning situation structuring • Resources and learning strategies selection • Self-evaluation of learning processes and products • Revision of regulation processes • Transfer of obtained knowledge to the new situations. • Self-responsibility for academic achievement	• Adaptive guidance for prerequisite based help • Personal construction on learning process	• Provision of expert model for users' self-regulation • Support of granular model for users' practice of self-regulation technique • Personal goal setting support system • Learning objective planning support systems for individual subject matter • Resources and strategy selection support systems for task specific performance improvement • Self-evaluation support systems based on each task or topic • Systems generated feedback to adjust the initial setting of goals and objectives
Self-awareness and Self-assessment	• Provision of Self-awareness and self-assessment for the learning process. • Support of learning environments for self review and self appraiser	• Personal construction on learning process	• Post diagnosis systems for self-progress assessment • Systems generated advice report based user self-diagnosis

Conclusion

The increase of the needs of Web-based instruction is indispensable in this information society due to its social, economic, and technological forces. Thousands of web-based courses and other educational application and resources are available in various formats but they are not guided, organized, monitored, nor evaluated to meet the individual needs and satisfaction. The advanced artificial intelligence technology for adaptive learning (content) management systems should be considered so that LMS/LCMS can contribute to raise the individual performance improvement and organizational impact to the next level and increase the return on investment.

References

Bembenutty, H., & Karabenick, S. A. (2004). Inherent association between academic delay of gratification, future time perspective, and self-regulated learning. *Educational Psychology Review, 16*(1), 35-57.

Bembenutty, H., & Karabenick, S. A. (2004). Inherent Association Between Academic Delay of Gratification, Future Time Perspective, and Self-Regulated Learning). Educational Psychology Review, 16(1), 35-57.

Brusilovsky, P. & Vassileva, J. (2003). Course Sequencing techniques for large-scale web-based education. *International Journal of Continuing Education and Lifelong Learning*. 13(1/2).

Bursilovsky, P., Eklund, J. & Schwarz E. (1998). Web-based Education for All: A Tool for Developing Adaptive Courseware in Proceedings of the 7th *International World Wide Web Conference (WWW'7). Computer Network and ISDN Systems*, 30(1-7), pp. 291-300.

Corno, L., & Mandinach, E. B. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychologist, 18*.

Corno, L., & Randi, L. (1999). A design theory for classroom instruction. In C. R. Reigeluth (Ed.), *Instructional design theories and model: A new paradigm of instructional design theory, Vol. II* (pp. 293-318). Hillsdale, NJ: Lawrence Erlbaum, Associates, Publishers.

Ley, K., & Young, D. B. (2001). Instructional principles for self-regulation. *Educational Technology Research and Development*, 49(2), 93-105.

McCombs, B. L. (1989). Self-regulated learning and academic achievement: A phenomenological view. In B.J. Zimmerman & D. H. Schunk (Eds.), *Self regulated learning and academic achievement: Theory, research, and practice* (pp. 51-82). New York: Springer Verlag, Publishers.

Niemi, H., Nevgi A. & Virtanen, P. (2003). Towards self-regulation in web-based learning. *Journal of Educational Media*,28 (1), 49-71.

Niemi, H., Nevgi, A., & Virtanen, P. (2003). Towards self-regulation in web-based learning. *Journal of Educational Media*. 28(1). 49-71.

Trawick, L & Corno, L. (1995). Expanding the volitional resources of urban community college students. *New Directions for Teaching and Learning*, 63, 57-70.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In Boekaerts, M., Pintrich, P. R., and Zeidner, M. (eds.) Handbook of Self-Regulation, San Diego, CA: Academic Press. pp. 13–39.