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Web Learning Systems and Cognitive Learning: A Survey

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***Abstract*—Web learning system is an innovative and powerful tool to enrich the teaching and learning processes. Web learning system has tremendous opportunities over the traditional learning environments. With the help of web learning system, different learning styles and approaches are achieved. The web learning system facilities to users experience, and also adapt the cognitive concepts like load, stress, recollection and retention. The adaptive learning support environment of the web learning system effectively accommodates a wide variety of students with different skills, background and cognitive learning styles. In this paper, various web-based learning system and aspects of cognitive associated with the web learning systems is surveyed.**

***Index Terms*—Web-Based Learning Systems and Cognitive Learning Style**

I. INTRODUCTION

WEB based learning system provides many benefits to the users compared to the traditional learning system. The web is a powerful learning environment for the students. Web learning systems offered to users have very effective methods, and the learning system adapts personalized approach based on various factors like age, interest, preferences, emotions and motivations. This paper mainly focuses on cognitive aspects associated with the system. The following sections deals with various web-based learning systems, e-Learning, cognitive styles and cognitive load.

II. WEB-BASED LEARNING SYSTEMS

Lisa Fan [1] presented a framework for a cognitive based adaptive web-based learning support system (WLSS) by focusing on learner's cognitive learning process and activities, as well as the technology support needed. This was due to the fact that for a web-based open and dynamic learning environment, personalized support for learners becomes important. In order to achieve optimal efficiency in a learning process, individual learner's cognitive learning style should be taken into account. Due to different types of learners using these systems, it is necessary to provide them with an individualized learning support system. Based on the learner-centered mode and cognitive learning theory, the study demonstrated online course design and development that supports students with learning flexibility and adaptability. The proposed framework utilizes a knowledge structure map for representing a dynamic cognitive learning process to support students' deep learning, efficient tutoring and collaboration in web-based learning environment.

In order to support the students' deep learning and understanding of difficult concepts about algorithms and data structures, a feasible framework by dynamically constructing knowledge structure map during the learning process was proposed. It can be visualized and clickable. Students can use his/her knowledge structure map to compare with the instructors or peers knowledge structure maps. When suitable knowledge structure is designed and constructed, the system can be used for effective learning, tutoring and problem solving, or diagnosing misconceptions.

Panagiotis Germanakos et al., [2] presented a Web-based adaptation and personalization system, AdaptiveWeb, which uses cognitive aspects as its core filtering element in a bid to adapt to user context, individual features and behavior patterns. This was because it is a challenge is to design personalized interfaces and software enabling easy access to the learning content while being sufficiently flexible to handle changes in a user's context, perception and available resources. The proposed system combines parameters like user's visual, cognitive and emotional characteristics "traditional" user profiling characteristics, to give an optimized adapted and personalized result to the user. The use of semantics enables the openness of the system as adequately described in the paper. The current system has been initially evaluated both at system's response time performance and resources consumption, as well as with regards to users' learning performance. A total of 72 experiments were conducted to load test functional behavior and measure performance of our system with controlled environments measuring average response times, throughput, deviation and median, ran by 100 threads (users). With regards to the users' learning performance, a correlation of cognitive processing speed and visual attention processing efficiency of users as well as intrinsic parameters of emotionality, with the parameters of online content was identified. The system has proved effective and efficient not only regarding the information flow within and between the various standalone system's components but also in respect to the actual output data gathered which reveals that the whole approach turned out to be initially successful.

Liang Jingjing and Zhan Qinglong [3] proposed an activity-centered model for web learning and user experience, based on activity theory, through the comparison with user-centered web design. The model emphasized that activities have great influence on web learning experiences and makes a further research on the design for web user experience from a perspective of activity theory. Web learning activities come from learners' needs and stimulate motivation for reaching purposes. The first step is the designs of activities and includes the analysis about the demands of learners or users of web (such as physiological demands, cognitive demands and emotional demands), collection of materials, data collection, feasibility analysis, the design for the objectives of activity, plans and analysis for the preparation. All the above arouse learners' curiosity and desire to learn, the learners will actively take part in the activities. The second step is the design of action. It includes design of performing manners, the anticipation of actions, construction of behaviors, the measures to problems and the ways to action. The third step IS the design of operation. To be specific, it consists of many detailed designs, such as the design of operation details, the interactive design, connection design and the design of operation manners. In the design for web learning and user experience, designers must investigate learners' demands, and only when these demands turn into activities, do they come true. Therefore, it is the core part of web learning to make a deep understanding about learners' activities. The application of activity theory and ACD could not only optimize web operability from the perspective of techniques, but also improve users' demands for web and effectively make web experience better in different ways.

III. E-LEARNING

Said Ghoniemy et al., [4] introduced an e-learning system to aid the learning process. The proposed system allows the students to browse through and then register for specific course. Tools like Blackboard, WebCT, Moodle are incorporated in the fields of Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) which are more tutor-oriented and not for personalized learning. The proposed system is innovative, user-friendly. Students have the option of planning their education and depending on the students need, the teachers can plan new ways to teach. Limited English proficiency and limited computer skills of the users impose limitations on the design and implementation of E-learning systems. SCORM standards are used to design the course.

Takashi Hirata et al., [5] have proposed and implemented a distributed e-Learning system. The user interface to communicate between agent and user's browsers is necessary in this system. And the old user interface analyses data and generates HTML on the browser-side. It was proposed and implemented for the user interface that analyses data and generates HTML on the agent-side. As a result, the user can use this system in any environment of their choice. The user interface treats contents that change dynamically including the function to tell the user grading results etc. Thus, the user interface needs the mechanism to generate document written in the HTML format dynamically. Above the reason and because it can directly access field of Maglog, the user interface is developed by Java Servlet. We intend to enable learning by a mobile device with a web browser that doesn't support JavaScript. Therefore, the study implements two kinds of view parts for a browser which support JavaScript and do not support it. This study developed a user interface that support multi web browsers. As a result, the user can use the proposed system in a favorite environment. The proposed system is expected to become more popular by the user interface

Sucheta V.Kolekar et al., [6] presented a recognizing the learning styles of individual student according to the actions or navigations that he or she performs on an e-learning application. This recognition technique is based on Machine Learning algorithm called Artificial Neural Networks and Web Usage Mining. This is because traditionally e-learning systems emphasized online content generation with most failing to consider the requirements and learning styles of end user, while representing it. Therefore, there is a need for adaptation to the user's learning behavior. Adaptive e-learning refers to an educational system that understands the learning content and the user interface according to pedagogical aspects. End users have unique ways of learning which might directly or indirectly affect learning process and its outcome. In order to implement effective and efficient e-learning, the system should be capable not only in adapting the course content to the individual characteristics of students but also concentrate on the adaptive user interface based on students' requirements.

The learning methodology in experiments aimed at extracting learning patterns of users to develop an Adaptive User Interface which enhanced learning efficiency by providing effective user interface and learning contents according to the user. Web usage mining and artificial neural network were utilized because of two unique advantages: 1) an automated mechanism for style recognition facilitating the gathering of information about learning preferences, making it imperceptible to students; and 2) the above mentioned algorithm used the recent history of system usage so that systems using this approach could recognize changes in learning styles or some of their dimensions over time. This is an important approach towards the personalized e-learning environment.

IV. COGNITIVE STYLE

Esra Yecan and Kursat Cagiltay [7] conducted a study to reveal the interaction patterns of users with different cognitive styles by using eye-tracking method. This was because users' psychological and physiological differences have been sought by researchers. Cognitive style –one of these differences- is related to a person's approach in getting, organizing, and processing information. It is indicated in literature that cognitive style has the potential to affect the users' interaction patterns in computer-based interfaces. The results indicated that users' fixation durations and places might vary among different cognitive style groups, but no statistically significant difference was found. The first research question searched for differences between the cognitive style groups in terms of fixation places. Findings didn't show that any frame or page is preferred by a group indicating a statistical significance. Namely, both groups equally focused on the menus. Similarly, each group focused on small chunk and large-chunk content presentations, and video page equal to the other group. On the other hand, descriptive data showed that, field dependent (FD) users usually had a better mean in average fixation durations, namely they spent more time than Field independent (FIs.)

Another issue examined was fixation durations on specific places of cognitive style groups. To answer this question, specific places were determined on the web site, and participants were traced during their study. Comparisons were made between the text fixations and image fixations of the users. In reality, there was no significant difference between the FD and FI participants in terms of text fixation means. As similar, the image fixation means were not statistically different among the cognitive style groups. Further analyses indicated that FD participants' fixation means on images and texts were not statistically different, similar to the findings of FI users. However, descriptive data indicated that FI users' image fixation means were higher than their text fixation means.

Nikos Tsianos et al., [8] present the empirical results of two distinct efforts to build and evaluate personalized applications in the field of education and commercial web-sites respectively. Individual differences in information processing, are derived from an approach that takes into account cognitive and emotional parameters, serves as a base for setting up a theoretical framework that addresses user profiling issues in web environments. In the educational context, this approach is shown to optimize learners' performance; the case of commercial environments seems more complex and elusive in measuring actual benefits. The theories involved in constructing a comprehensive information processing model are presented, and the adaptation rules and changes within the environment are discussed, in relation to the empirical results that were gathered throughout the development of the proposed model. It is argued that individual differences are nevertheless present during users' interactions within the information space and that web environments should be adapted on such intrinsic characteristics.

The study proved that applying an individual differences approach as a personalization procedure in web environments had a positive effect in the case of educational settings. Users perform better when their intrinsic characteristics are taken into account, and the mapping and implication rules that were implemented seem to be in the right direction. Thus, when designing environments that involve information processing, emphasis should also be placed upon users' characteristics and abilities. Extending this approach in fields other than the web, such as virtual settings, individual differences could also be important in terms of comprehension, navigation and orientation.

Huan Wang and Mei Guan [9] have undertaken an online study which revealed that to avoid unconcerned information processing , to spiriting the leaning motivation, the memory activities' transferring and the cognitive activities' transferring are four strategies that can be used to relieve the cognitive in online leaning and increase the leaning efficiency. Cognitive loads exist in any mode of study and it is a very important factor in the affection on the learning effect. By comparison with other learning styles, the cognitive load of the students who study online seemed heavier. The study revealed that better results could be obtained if part of simple cognitive activity was shifted to a computer which because of its efficiency in some tasks while complicated cognitive activities – which the computer cannot handle can be done by students. This can be achieved by setting calculator, excel sheet or other tools in the website to carryout computational activity. Complicated cognitive activity will cost a huge amount of cognitive resource. People can reduce the stress of the working memory's complicated cognitive activity by offering a data operational mode, so, that students need not waste energy to calculate each strategy. Finally they suggested building a learning community to make metacognition transfer possible, this will help students be inspired and correct their thinking based on the feedback. Intercommunion in the learning community can be the tool of self-examination and feedback for students, to help them develop meta-cognition and thereby lighten the cognitive load.

Norol Hamiza Zamzuri et al., [10] explored the user characteristics, users cognitive styles, their current views about e-learning usability and perceived importance of its usability design features. The study of the usability of e-learning courseware and its significance in the instructional design process is based on the survey conducted on a Malaysian university where e-learning is widely used. Based on the analysis it was found that there was a relationship between users' current view and users' perceived importance of interface design. This could result in considering the usability characteristic in designing features. The result is also consistent with the study as most of respondents agree that the usability characteristic in designing the system are based on certain criteria and it was also found that most of the respondents believe the importance of the criteria in designing the interface. However, although cognitive style has been found to influence usability in other studies, it does not contribute to the e-learning usability and perceived importance features in the current study. A comparison between genders reveals that there are significant differences between males and females in their views on e-learning usability and perceived importance e-learning features.

V. COGNITIVE LOAD

Andrea Niculescu et al., [11] conducted experiments to determine how low/high levels of stress affecting cognitive load are achieved while interacting with the system. This was because stress and cognitive load are two influence parameters which determine the quality assessment of multimodal conversational interactions and the experiment was to assess the impact of stress and cognitive load on conversational interactions to control their levels during interaction. Different levels were manipulated by varying task difficulty (information complexity, task load, and simulated speech recognition errors), information presentation (modality usage, spatial organization and temporal order of information items) and time pressure. Heart rate variability (HRV) and galvanic skin response (GSR) as well as subjective judgments in the form of questionnaires were deployed to validate induced stress and cognitive levels. Methods and preliminary results are presented.

The results showed that cognitive load and stress were better indicated by subjective reports than by physiological measurement. It was also revealed that cognitive load could be better manipulated compared to the stress, a not surprising fact since stress is usually due to mentally demanding situations. The learning effect visible in the measurements disturbed the manipulation of the expected low/high levels. This effect might be weakened by a training session performed before the experiment's start. The present experimental design was considered a good starting point for forthcoming investigations concerning effects of stress and cognitive load on the conversational quality assessment.

Shipin Chen and Jianping Zhang [12] state that Adaptive learning system, is a kind of online learning environment that supports the individual learning. It changes the traditional "just put it on the web" approach, and provides the customized learning according to the individual differences. In order to reducing the "cognition overload" and "disoriented" architecture of Adaptive Learning System based on Learning Style and Cognitive State (ALS-LSCS) is put forward in this paper. Referencing AHAM model, the architecture of ALS-LSCS is mainly composed of the Media Space, Domain Model, Instruction Model, Learner Model, Adaptive Model and the User Interface. To record the cognitive state and learning style of learners, Learner Model combines the Stereotype with the Multi-layered Overlay Model. According to the Felder-Silverman categories, learning style is represented in Stereotype. Cognitive state is recorded in Multi-layered Overlay Model. ALS-LSCS selects the learning content based on learner's cognitive state, and presents learning content through selective teaching media based on learner's learning style. With the rapid development of artificial intelligence in education, adaptive learning system has become a development trend of web-based e-learning systems. Adaptive learning systems can provide customized learning according to the learner's differences. Learner Model is the key component that adaptive learning system can achieve to adaptation. Learner Model records individual characteristics of the learner, and can be dynamically updated during the learning process. Thus, ALS-LSCS not only tailors the instruction to the needs of learner, but also realizes the reuse of domain knowledge, and supports the "collaborative learning".

VI. CONCLUSION

The web learning users need innovative methods incorporated in the learning system, for motivated learning activity. The web learning system focuses on user's experience, cognitive characteristics, and demands. The web learning design demands a deep understanding about learner's activity and also focus on improve user's requirements based on cognitive approach. In this paper, various web-based learning system and aspects of cognitive associated with the web learning systems is surveyed.

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