SHORT-TERM LEARNERS' MOTIVATION MODELING IN WEB BASED EDUCATION SYSTEM

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ABSTRACT

Recent research regarding personalized web based educational systems demonstrate learners' motivation to be an essential component of the learning model. This is due to the fact that low motivation results in either students' less engagement or complete drop out from the learning activities. A learner motivation model is considered to be a set of perceptions and beliefs that the system has developed about a learner. This includes both short-term and long-term motivation of learners. Short-term motivation encompasses specific, challenging and attainable goals that develop in the limited timespan. On the other hand, long-term motivation indicates a sort of continuing commitment that is required to complete assigned task. Since, short-term motivational problems span for a limited period of time such as a session, therefore, needs to be addressed in real-time to keep the learner engaged in the learning process. This paper proposes the framework of a domain independent short-term learner motivation model based on Keller ARCS motivation theory and Social Cognitive Theory. The proposed motivation identification framework consists of two modules. The primary module deals with real time identification of motivation, and the secondary module maintains the profile of learners associated with the short-term motivation.

1. INTRODUCTION

Web based learning is getting prevalent in the present era. This make the learners to learn anywhere and anytime. Moreover, it allows learner to learn at their own pace (Acadamic Resources., 2017). There are two modes of delivering information in web-based learning that is synchronous and asynchronous (Ramaha and Ismail, 2012; Lim, 2017). Asynchronous mode let the students to take courses at own pace. Similarly, they have the choice to learn at different times according to their own schedule. This mode includes some common features such as message boards, discussion forums and self-paced courses. Real-time communication between students and instructors is a limitation in this method. On the other hand, synchronous methods let the students to enroll in a class that is paced at a particular interval. Student and teachers can interact in real time via video conferencing and web chat. Hrastinski (2008) describes that learners are more motivated in synchronous mode compare to asynchronous mode, due to its resemblance with the face-to-face communication. Keller and Suzuki (2004) indicated drop out as an important challenge in asynchronous mode. This is because learners feel lonely and isolated.

Abas (2003) illustrated that the success of web-based education system mainly depended on how well the system keeps the students motivated, energized and excited to learn. Therefore, identification of learner motivation is a vital research issue both in traditional class room environment as well as in web-based education systems. Research about incorporating motivational aspects in adaptive learning systems is reported as a critical research issue (Weld *et al.*, 2012; Fryer and Bovee, 2016).

Due to the rapid technological advancements, e-learning has been changed from the simple ways of delivering content to the complex learning environments such as recommender systems (Abas, 2003). This change arises the need to consider motivation in a more personalized way and to build adequate interventional strategies for learners' motivation (Ramaha and Ismail, 2012). Therefore, many researchers emphasize on providing personalized interventional strategies based on a firm learners' motivation model (Keller and Suzuki, 2004; Hrastinski, 2008). Although, there are several studies available which tries to analyses and identify

learners' motivation both in traditional classroom environment and web-based e-learning systems. However, there is a very little research that has been conducted to identify learners' motivation in real time. Therefore, the need of motivational diagnosis and including short-term motivation model in web-based education system arises, that can assess and resolve learners' motivation issues in real time.

Cocea (2006) indicated that motivation model of learners must be based on a firm and well-established learning motivation theory. Therefore, this research takes Keller's ARCS Motivational Model and Social Cognitive Theory (Self- Regulation) as the basis for the framework of short-term motivation model. The framework consists of two modules. The primary module deals with real time identification of motivation, and the secondary module maintains the profile of learners associated with the short-term learners' motivation. The research is structured as follows: Section two describes the related work. Section three explains the framework for identification and modelling of short-term learners' motivation. Section four conclude the research work. Finally, section five presents the future work.

2. RELATED WORK

Initially, motivation has been perceived as a matter of design in web-based education systems. Specifically, learner can be engaged in learning through information presentation and providing efficient and effective instruction (Cocea and Weibelzahl, 2006b). Matsuo et al. (2008) used learners' study history, encourage function, etc. to implement / stimulate motivational design. Similarly, Burguillo (2010) describe introduction of friendly competitions among students. This enables students to increase their performance and results. Designing an e-learning curriculum that keep learner motivated during the complete learning program is one of the major issues in web-based education systems (Ghergulescu and Muntean, 2010). However, Cocea (2006) indicated that design approach does not take into account the personalized characteristics of the learners. Therefore, design strategy does not play an active role to enhance learners' motivation. As far as traditional class room environment is concerned, expert instructors generally deduce motivation of the learner from observational cues such as attitude, posture, gesture, conversation etc. which are challenging to be processed by computer (Cocea, 2006). Consequently, studies in the field of web-based education systems are mostly directed towards finding a way for the assessment of motivation utilizing cues. These cues must be easily processed by the e-learning systems such as learners' actions, learners' opinion about their level of motivation, and time spent on a given task.

This led the research to another strategy based on the log file analysis. Unobtrusiveness of the evaluation method is the key advantage of this approach. It is similar to the traditional classroom scenario where an instructor can perceive learners' motivation without interfering his/ her activities (Cocea, 2006). Zhang et al. (2003) used factorial analysis approach to identify motivation of the learner in a programming course. Two motivational traits of ARCS model (Keller and Suzuki, 2004) attention and confidence were taken into account. Results of their research work indicated that by means of factorial analysis user's action can be grouped, to differentiate between related actions that predict attention and confidence.

For log analysis, a rule-based methodology is developed by De Vicente and Pain (2002) to detect the motivational states of the learner using motivational characteristics. Qu, Wang and Johnson (2005) targeted aspects of learners' motivation such as effort, confidence, and confusion. Many cues related to the learners' actions were considered. This includes time to read the paragraph related to the task, time to perform the task, and the time when the learner starts/ finishes the task. Moreover, it considers, the time for the learner to decide how to perform the task, the number of tasks the learner has finished with respect to the current plan, number of questions asking for help, and the number of unexpected tasks performed by the learner (Qu, Wang and Johnson, 2005; Cocea, 2006). A dynamic mixture model was proposed by Johns and Woolf (2006). This model relates a hidden Markov model with IRT (Item Response Theory). Learners' skill, motivation, signs of motivation, and learners' reaction to a problem are the traits used in model to incorporate motivational aspect of the learner.

Nevertheless, motivational characteristics are not always evident and therefore invisible by observation (Cocea, 2006). This led the research to another strategy known as self-assessment that would also guarantee the accurate information. Learners' self-assessment has been proved to be reliable, helpful and precise source of motivational information (Beal, Qu and Lee, 2006). This research therefore uses both log file analysis and learners' self-assessment. Log file analysis would provide the benefit of unobtrusiveness and the learners' feedback/ self-assessment would provide the accurate information about learners' motivation.

3. FRAMEWORK FOR SHORT-TERM LEARNERS' MOTIVATION MODELING

This methodology is built on Keller's ARCS motivational model and Social Cognitive Theory. This framework includes characteristics such as Attention, Relevance, Confidence, and Satisfaction from Keller model and Self- Regulation from Social Cognitive Theory. Real time motivational status of the learner is stored in short-term motivation model. This method is shown in Figure 1.
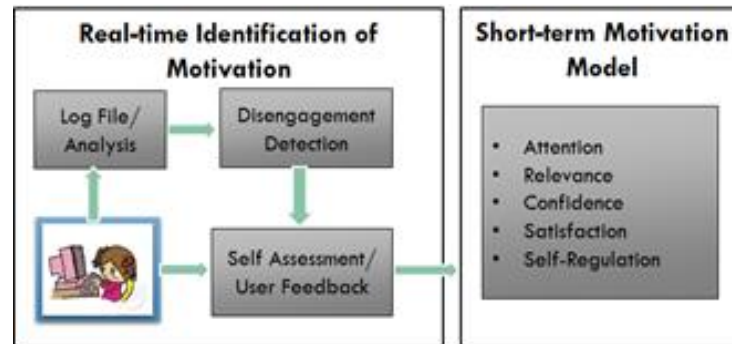

Figure 1. Short Term Learners' Motivation Modeling Framework

First step for short term motivation model is eliciting most appropriate motivational problems in web-based learning. For this, a generic list of motivational problem was drawn based on the research and commendations discussed in the related work (Cocea, 2006; ChanLin, 2009). The primary list included 28 motivational problems that were faced in web-based learning (See Appendix). All the motivational problems are assigned with a unique problem ID for example A1 for Attention problem no 1.

An online survey was conducted to rate the most frequent motivational problems on the Likert scale, involving expert from the Moodle research community and undergraduate online learners of Virtual University of Pakistan. There were three reasons for seeking the views of experts and online learners:

(a) To elicit motivational problems that are best suited for the different characteristics outlined in the list.
(b) To rate most frequent motivational problems; and
(c) To validate the motivational problems contained in the list.

The survey was conducted using Google Forms. The online learners were given the list of motivational problems with the characteristics and were asked to rate the motivational problems on the Likert scale (where 1 represent rarely and 5 represent mostly) from each of the four domains of Keller motivational model and one from each of three domains of self-regulation. The learners were asked to suggest any further motivational problem that they faced during interaction with online learning environment. This question was asked in order to elicit any motivational problem that may have been overlooked when the list was being compiled.

The results show that mean value of the motivational problems ranges from 2.3 to 3.5 (see Figure 2). The motivational problems were then arranged according to the rating of the participants and would be presented to the learner in a dialogue to report their motivational state.

For the next step, input of the learner from the dialogue would be feed to short-term learner model with problem ID, time, date, and course ID (see Fig 3). Moreover, recommended strategies for intervention would be provided to instructor along with problem ID, to keep the learner motivated in learning process. Instructor would be allowed to mark the motivational problem as resolved when the intervention is provided to the learner. The short-term motivation model would be updated, and the time, date, and course ID fields would be assigned with null value.
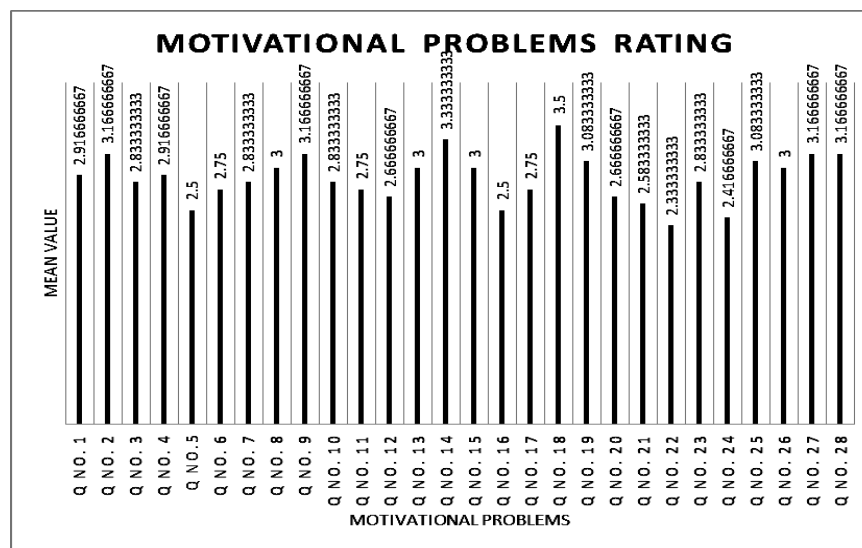
MOTIVATIONAL PROBLEMS RATING

Figure 2. Results of online survey

3.1 Log File Analysis/ Disengagement Detection

As discussed earlier, the key benefit of log file analysis is the unobtrusiveness of the motivational assessment process. However motivational characteristics are not always evident and therefore untraceable by observation. For example, a general indicator of engagement or disengagement is time spend on a topic (Cocea and Weibelzahl, 2006a). Time spend (too short or too long) on a topic or task may specify disengagement. Obviously, both could be due to some other reasons, for example one can explain a short time duration spent on a topic might be due to fair or prior knowledge of the topic. On the other hand, a too long time could be advocated by causes such as deep thought breaks. This would recommend the use of self-assessment/ learner feedback that would also confirm the accurateness of information. However, obtrusiveness of the process is limitation in self-assessment.

Similar to Cocea and Weibelzahl (2006) research, this paper proposes an approach that combines the log file analysis and learner feedback. This balances the benefit of unobtrusiveness offered by Log file with the significance of accuracy of information provided by Learner Self-assessment. So, the proposed approach is divided in two phases that is log file analysis and learners' self-assessment. The initial phase is disengagement detection using log file analysis. This would guarantee that a learner would be interrupted only when identified as disengaged by the system. Similarly, in second phase, as soon as disengagement is identified, the system would ask the learner about their motivational state. If the learner approves system diagnosis, a dialog would be initiated by system and asks the student to provide information about their motivational state.

As discussed earlier, there are some behavioral cues which indicates disengagement of the learner. For example, non-systematic progression, skipping sections, browsing fast rather than reading, and quickly answering the questions, that is even in less time that is essential to read the questions. This paper considered reading time, mouse movement and correct / wrong answers of the question at the end of each topic as the indicators of motivation. An average man can read with the speed of 200 to 250 words per minute assuming user did not skim the words nor fail to understand the meaning of what was read (Speed Reading Facts., 2018). So, we can calculate minimum average time of a page by the following formula.

$$minTimeReq(Seconds) = \frac{No\ of\ words\ on\ the\ page}{maximum\ Average\ Speed\ (250\ words/minute)} \times 60$$

Similarly, maximum average time of a page can be calculated as follows.

$$maxTimeReq(Seconds) = \frac{No\ of\ words\ on\ the\ page}{minimum\ Average\ Speed\ (200\ words/minute)} \times 60$$
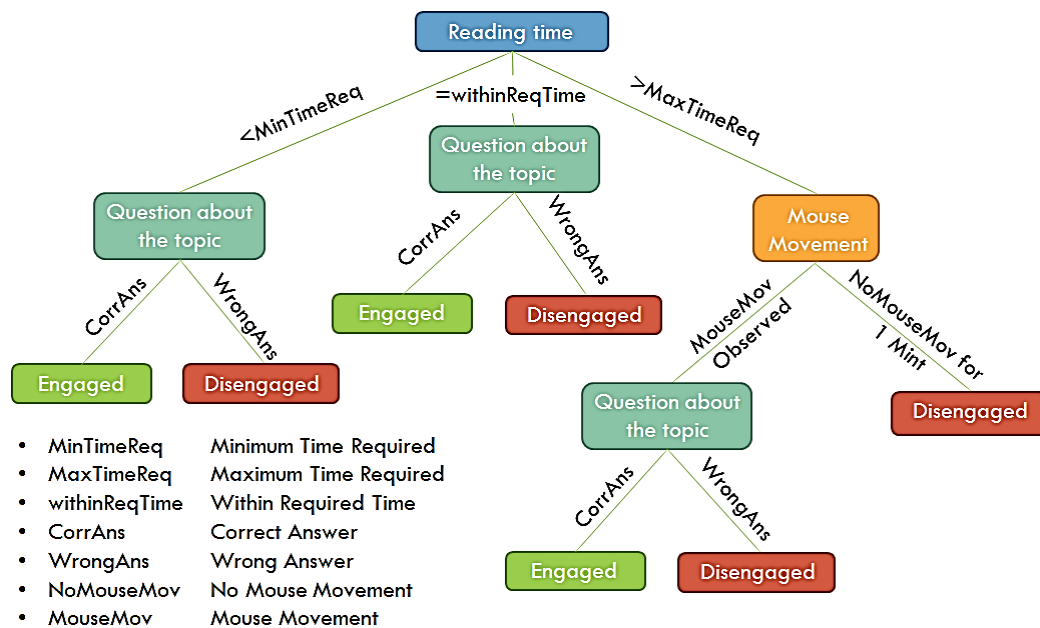
Figure 3. Process to identify real time engagement/disengagement of the learner

The Figure 3 shows the process to identify real time motivation of the learner. A good level of motivation is termed as engaged and low level of motivation is termed as disengaged in Fig 3. In case the learners' reading time is less than the minimum time required to read and understand the topic, the system would ask a question at the end of the topic. If the learner correctly answers the question, system would consider learner as engaged and allow the learner to proceed to the next topic. On the other hand, if the learner fails to answer the question correctly, the system would inform the learner that it has detected disengagement. If the learner approves system diagnosis, the system would initiate a dialog. The questions could be MCQs and fill in the blanks or both. A fill in the blank question would be a good idea so the blind guess can be avoided.

In the same context, if the learner read the page within required time and answer the question correctly, would be identified as engaged by the system. On the other hand, if a learner spends too much time on a page i.e. greater then maximum time required to read the page, the system would observe the mouse movement for a minute. If no mouse movement is observed by the system for one minute, it would ask the learner about his/her motivational state. The system would expire the session time if the learner doesn't response for a while and update his/her user model. Conversely, if the system observes the mouse movement, it would wait until the learner answer the question at the end of the page. The system would classify the learner as engaged if the answer is correct otherwise disengaged and asked for the motivational state.

3.2 Self-Assessment / Learners' Feedback

The purpose of the learner feedback is to involve a learner in a dialogue process with the system reported as disengaged. This would enable the system to identify some motivational traits that would further be used to update learners' motivational model.

The conversation would be initiated by notifying the learner that they are detected as disengaged by the system, followed by a question intended to confirm whether the student agrees with the diagnosis of the system or not. The dialogue is presented with mostly occur motivational problem at the top followed by less occurred motivational problems as categorized using google survey discussed earlier. Knowing the fact that the learner providing the information would already be disengaged, only first ten problems would be presented on the first page to elicit motivational problems. Learner can select one or more option in the following dialogue to report their motivational problems. In case the specific motivational problem is not presented, the learner would be provided with next ten problems on second page and so on. The selected motivational problem would be feed to short-term motivational model.

3.3 Short-Term Motivation Model

The short-term learners' motivation model would receive information from the disengagement detection section and learner feedback. The reported motivational problem would provide values for the motivational characteristics i.e. Attention, Relevance, Confidence, Satisfaction, and Self-Regulation. Similarly, the motivational problem would be registered in short-term motivational model of the learner with Problem ID, Course ID, Time and Date (see Fig 4).

The disengagement detection would provide real-time information about learners' motivation state. At the bottom of short-term motivation model, recommended strategies would be provided to instructor to resolve each motivational problem. This would enable instructor to provide personalized intervention to the learner.

	Problem ID	Time	Date	Course ID	
Attention	A1	-	-	-	
	A2	1545	20160107	WP1	Resolve
	A3	-	-	-	
	A4	-	-	-	
Relevance	R1	-	-	-	
	R2	-	-	-	
	R3	-	-	-	
	R4	-	-	-	
Confidence	C1	-	-	-	
	C2	-	-	-	
	C3	-	-	-	
	C4	1134	20160108	WP1	Resolve
	C5	-	-	-	
Satisfaction	S1	-	-	-	
	S2	-	-	-	
	S3	-	-	-	
Self Regulation	SR1	-	-	-	
	SR2	-	-	-	
	SR3	-	-	-	
	SR4	-	-	-	
	SR5	-	-	-	
	SR6	-	-	-	
	SR7	-	-	-	
	SR8	-	-	-	
	SR9	-	-	-	
	SR10	-	-	-	
	SR11	-	-	-	
	SR12	-	-	-	

Recommended Strategies

A2: Post reminding of learning activities.
C4: Encourage the learner to recognize the content and understand what they learnt.

Figure 4. Short-term Learners' Motivational Model

4. CONCLUSION

Motivational diagnosis is important for both traditional class room and web-based education systems. It is one of the major elements that contribute in the success of the learning process. However, dropout rate among online students is very high which lead to incorporate motivational elements in more personalized way. Because motivated students will retain the course until they successfully complete it. Hence, identifying learners' motivation and providing personalized intervention is key for the success of web-based education systems.

This paper presented a framework for real-time identification of the learners' motivation. Log file analysis was proposed to detect the real-time learners' motivation. Reading speed, mouse movement and correct answer to question at the end of the page were attributes considered for motivational diagnosis. Learners'

self-assessment was used to ensure the accuracy of the motivation identification process as user feedback is proved as a helpful, reliable and precise source of learners' motivational information. The presented framework is based on widely recognized and firmed research methodologies. So, it is believed that the presented model would enhance the learning process by motivational diagnosis of the learner and assisting instructors to provide personalized intervention based on system diagnosis.

5. FUTURE WORK

Future work deals with the development of learner motivational model incorporating both long-term and short-term motivational characteristics. Moreover, an experiment would be conducted to know the impact of motivational model over the dropout rate of learners.

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APPENDIX

Initial List of Motivational Problems

Problem ID	Motivational Characteristics	Motivational Problems
A1	Attention	The content area was not interesting as expected.
A2		Online class attendance did not concern me.
A3		Unlike face-to-face meeting, I had problems in attending to each learning task.
A4		Knowing that we have plenty of time to learn in a Web-based class, we paid less attention to the specific learning time.
R1	Relevance	A lot of unfamiliar materials were involved in the lesson.
R2		Inappropriate experiences, such as weak theoretical-grounded folk prescriptions were related to the course due to uncertainty about the content.
R3		Use of discussion forum was found irrelevant to learning content.
R4		I am not accustomed to chat for course related content.
C1	Confidence	Knowledge we explored was so extensive that I had problems preparing for the exam' websites.
C2		I believe, I cannot understand it.
C3		Learning from the foreign websites do not provide desired results.
C4		The content is too hard to understand.
C5		There is always an uncertainty about the use of Web-based resources for assignments and research projects.
S1	Satisfaction	'Too much work!' 'Lack of time!'.
S2		'Not seeing class members made me feel insecure about the course'.
S3		I often fail to participate in course activities and fail to submit assignments regularly.
SR1	Self-Regulation	In a tough situation I cannot stick to the schedule I have made for myself.
SR2		I cannot stick to a certain timetable when I'm studying.
SR3		I have used the time that I have reserved for studying.
SR4		I never stick to the study schedule that I have made.
SR5		Requirements of this course did not match with my own style of studying.
SR6		Before a study activity, I often go through its different steps in my mind. These steps are not provided in the beginning of the activity.
SR7		I set learning goals to be able to direct my studies, but I am unable to meet them.
SR8		I think I performed badly in this study activity and I cannot improve my performance.
SR9		I often feel so lazy or bored studying course literature that I quit before finishing.
SR10		I often give up when I'm studying difficult issues and focus on the easier ones.
SR11		I often feel difficulties in motivating myself to complete the study tasks if they are not particularly interesting to me.
SR12		I often give up if I don't like all the tasks or the material I am reading.