MoGAME: Motivation based Game Level Adaptation Mechanism

Ioana Ghergulescu and Cristina Hava Muntean

National College of Ireland, School of Computing
Mayor Street, Dublin 1, Ireland
ioana.ghergulescu@student.ncirl.ie
cmuntean@ncirl.ie

Paper Type: Research

Abstract

Nowadays, students are spending more and more time doing online entertainment activities rather than learning. In this context a lot of research in the area of e-learning was put in combining the entertainment with teaching in order to increase the student motivation for learning. The fact that the learning process may be considered by the students to be a boring and forced process which leads to student de-motivation remains an issue. In this context, educational games were developed in order to support the learning process. This paper presents a Motivation based Game Level Adaptation Mechanism (MoGAME). The proposed mechanism combines motivation assessment and learner knowledge in order to personalise the game difficulty level. Thus, the game will be not too easy to bore the learner and not too hard to be impossible to be played. Providing the learner with real time feedback, acknowledging their results and rewarding their achievements will increase their motivation and their belief that they are capable of continuing with the learning process.

Keywords: motivation, gaming, adaptive e-learning

MoGAME: Motivation based Game Level Adaptation Mechanism

Ioana Ghergulescu and Cristina Hava Muntean

National College of Ireland, School of Computing
Mayor Street, Dublin 1, Ireland
ioana.ghergulescu@student.ncirl.ie
cmuntean@ncirl.ie

Abstract

Nowadays, students are spending more and more time doing online entertainment activities rather than learning. In this context a lot of research in the area of e-learning was put in combining the entertainment with teaching in order to increase the student motivation for learning. The fact that the learning process may be considered by the students to be a boring and forced process which leads to student de-motivation remains an issue. In this context, educational games were developed in order to support the learning process. This paper presents a Motivation based Game Level Adaptation Mechanism (MoGAME). The proposed mechanism combines motivation assessment and learner knowledge in order to personalise the game difficulty level. Thus, the game will be not too easy to bore the learner and not too hard to be impossible to be played. Providing the learner with real time feedback, acknowledging their results and rewarding their achievements will increase their motivation and their belief that they are capable of continuing with the learning process.

Keywords: motivation, gaming, adaptive e-learning

1 Introduction

In the Internet age, day to day activities like communication, learning and entertainment are used at different levels. Nowadays, students use different gadgets for entertainment and recreation, and spend on average at least 22 hours/week doing online activities and they are perceived as being a "Net Generation" (Smith et al., 2009).

Reaching and engaging learners is considered a challenge for teaching (Little & Page, 2009), while the learning process may be considered by the students to be boring and forced. However, learning and teaching have evolved and new technologies that enhance learning were introduced. E-learning systems have also evolved significantly over the past years towards Adaptive e-Learning Systems (AeLS) that make use of the learner's preferences, knowledge and goals in order to adapt the delivered content. Various AeLS (Muntean, 2008; Muntean & McManis, 2006, De Bra et al., 2006; Chang et al., 2007) were proposed over the last decade and they were successfully tested within different educational institutions.

Educational games came to solve the lack of motivation during learning process. Burgos et al. (2007) mentioned that games represent a motivational enhancement in the learning process. Computer games clearly facilitate students learning (Chuang & Chen, 2009) because "a motivated learner cannot be stopped"

(Prensky, 2003). Other experimental studies have also shown that motivation increases when games are used in the e-learning context (Batson& Feinberg, 2005).

PlayLearn is a component for AeLS which adds support for playing educational games within an e-learning environment (Ghergulescu & Muntean, 2009). This paper extends PlayLearn by combining motivation assessment and learner knowledge determined by AeLS in order to personalise the game.

The remaining paper is structured as follows. Section two presents research efforts in the area of gaming in e-learning and measuring e-learner motivation. Section three presents the MoGAME, whereas at the end conclusion and future work are indicated.

2 Related work

Our research combines two areas: motivation in e-learning and gaming based e-learning. Therefore, research work done in the two areas is presented next.

2.1 Measuring e-learner's motivation

Motivation represents an important factor for learning. In the e-learning context, motivation detection and measurement is a challenging process since learner's speaking tone and behaviour cues cannot be analysed as in traditional learning that involves direct content with the learner. Next, a classification of the current solutions proposed for assessing the e-learner motivation is presented.

2.1.1 Analysis of motivation using learner interaction with the e-learning system

When a learner interacts with the e-learning system, information such as visited links, mouse movements and time are saved in a log file by the system.

The time elements measured are: the time spent on performing the task, the time spent per session, the pace time of an activity, the time between two consecutive sessions, the time spent on the quiz/test/pre-test, the time spent on reading a page and the time from login until the student performs a task (Hershkovitz & Nachmias, 2009; Cocea & Weibelzahl, 2009; 2007a; 2007b; Qu et al., 2005, Tran et al., 2009).

Mouse movements include: the maximum time not using the mouse, average x movement, average y movements, the maximum time interval in which the mouse is not used for a current problem (Ben- Zadok et al., 2009). Analyses of how the learners used the mouse in their actions are performed based on the mouse movement.

Possible performed actions that can be quantized and measured are: the total number of studying days, the number of messages posted (Chyung, 2007), the percentage of correct answers, the number of help pages requested.

2.1.2 Analysis of motivation using additional equipment

Information that is difficult to be stored by an e-learning system like eye movements and gestures can be retrieved using additional equipment (e. g. eye tracking system (Gutl et al., 2005)). Emotions, learner's behaviour, eye movements indicate learner motivation. Humans' emotions can be measured by analysing and tracking the eyes (de Lemos et al., 2008).

2.1.3 Analysis of motivation through direct human's interaction with the learner

Motivation can be measured by direct interaction with the learner through interviews, questionnaires, and self-reports. Takemura et al. (2008) developed a questionnaire to be used for measuring the e-learner motivation. The authors measured the motivation with a programming course. The tests were performed during a semester. In this period, the questionnaire was used three times: early, halfway through and late in the semester. The same course was tested within two universities, one in Japan and the other one in Taiwan. The results have shown that student's motivation increased in one university (University from Taiwan) while it dropped with the other one (University from Japan). This shows the motivation's variation and the need for a real time measurement instrument. Verbal communication is difficult to be used with an e-learning system. Information that could be taken from interview (from verbal communication) is replaced by the information collected via an online dialog system. Affective Dialoguer (AFDI) (De Vicente & Pain, 2000) was developed in order to measure e-learner motivation. AFDI, a knowledge-based rules system is able to generate a dialogue. During a dialogue with AFDI, the learner has the choice to replay. Based on learner's choice the model state is updated. Self reports' were also used in order to give information about the motivation state of the student but, on other side, self report can become a disengaged element (De Vicente & Pain).

2.1.4 Analysis of motivation by combining previous techniques

Cocea & Weibelzahl (2009) combined analysis of motivation using the learner interaction with the e-learning system and questionnaire. The time elements measured were: the number of reading pages, the average time spent reading, the number of performed tests and the average time interval required to perform a task. The authors proposed a classification of the learners in two categories: engaged and disengaged learners. The classification was made based on assessing information from log files.

Sometimes the e-learner may trick the system. Interpreting such behaviour may conduce to a wrong detection of the motivation level. Studies were made in order to detect the learner's behaviour (Cetintas et al., 2009; Baker, 2007). Time elements and mouse movement from the learner interaction with the e-learning system, and learning performance for detecting learner's behaviour were used. After detecting user behaviour and the fact that the user does not trick the system, the variables that measure learner motivation are more feasible. Cetintas et al. (2009) tracked and analysed mouse movement with learning performance and time elements. They investigated three techniques for measuring e-learner behaviour: technique using only time elements, technique using time elements and learning performance, and technique using time element, learning performance and mouse movements.

2.2 Gaming in e-learning

Berger & Muller (2009) define gaming based learning as a motivational device that brings a layer of emotional content on the top of instructional content.

Whitton (2007) presented a study of motivational potential in computer game based learning in higher education. The results show that game players had different motivation for playing games. Also three distinct primary motivations for playing

games merged: the mental challenge, the psychical challenge and the social experience. Gee & Lee (2008) explored the use of gaming in learning experience. They used games to teach geography. Using survey questionnaire they measured knowledge competence, motivation to learn and satisfaction with the learning material. The results have shown that when learning is made with the help of games, 70% of the students acquired knowledge and facts, 66% were more motivated to challenge themselves to achieve better score, 66% considered that the learning material and content met their learning objectives.

Chuang & Chen (2009) made an experimental study with one hundred fifteen one 3rd level students. They compared two different types of instructional treatment: traditional computer-assisted instruction and computer-based video game instruction, by looking at their learning performance. They used post test scores for data analysis. The overall reliability of their studies was 0.88. Students' knowledge achievement scores, from computer- based video game instruction group, outperformed students' knowledge achievement from traditional computer- assisted instruction group.

Batson & Feinberg (2005) developed and tested a credit card game for high school students based on the Gardner's multiple intelligence learning theory. The results have shown that the majority of students were motivated to play the game and perceived it a positive learning experience. The target group was 13-18 years old learners. 77% of the learners felt that they are achieving knowledge. A questionnaire was used for measuring motivation. Students playing the game were highly motivated to learn about credit cards and how to use it (84% of the students).

Gaming based e-learning has evolved. Frameworks for integrating adaptive educational games in e-learning were proposed (Berger & Muller, 2009; Blanco et al., 2009; Moreno-Ger et al., 2008). Adaptation plays a very important role in the quality of the educational game experience (Moreno-Ger et al. 2008). Blanco et al. (2009) proposed a general architecture which integrates educational video games into the e-learning system. Berger & Muller (2009) proposed architecture for educational game as a notion of story with joining element of arbitrary learning paths.

Previous research work done by us investigated the integration of entertainment games into an adaptive e-learning system, through PlayLearn component. The feasibility and people opinion on using entertainment games were assessed though interviews and questionnaires with seventeen undergraduate students. The results show that most of the subjects (88.24%), have felt as being favorable towards the introduction of a gaming based break in the learning process, 82.35% also believed that the game have motivated their learning desire. Only a small number of students (17.65%) considered the introduction of a game as being a disturbing in the learning process (Ghergulescu & Muntean, 2009).

Hunicke (2005) argued that games are boring when they are too easily, and frustrating when the game is too difficult. There is a need for bringing balance in a game. He examines the effectiveness of dynamic difficulty adjustment by adapting the game level. The study indicates that adjustment algorithms can improve performance.

3 Motivation based Game Level Adaptation Mechanism (MoGAME)

PlayLearn is a component integrated with an AeLS (e. g. AHA). The architecture of PlayLearn- AHA are illustrated in Figure 1. In order to integrate PlayLearn with an

AeLS we have extended the generic AeLS architecture that mainly consists of a User Model, a Domain Model and an Adaptation Model with PlayLearn.

User Model contains information of user's knowledge, goals and preferences. Domain Model consists of educational concepts to be taught organised in a hierarchical structure where relationships exist between them. Adaptation Model consists of rules used during both content and navigation support personalisation process. These rules combine information from the DM and UM in order to provide a personalised educational content.

We propose to extend PlayLearn with a mechanism (MoGAME) that adapts the game level according to the e-learner motivation and knowledge level. MoGAME bases its adaptation on time related variables, performance related variables and self-efficacy.

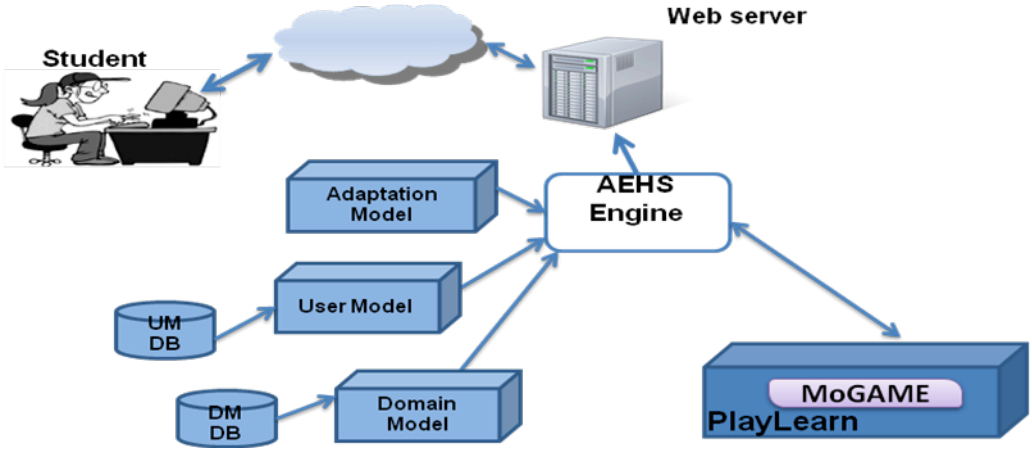

Figure 1 AeLS architecture extended with PlayLearn

MoGAME provides the next game level based on the learner's motivation level and knowledge level provided by User Model. MoGAME's block diagram is illustrated in Figure 2.

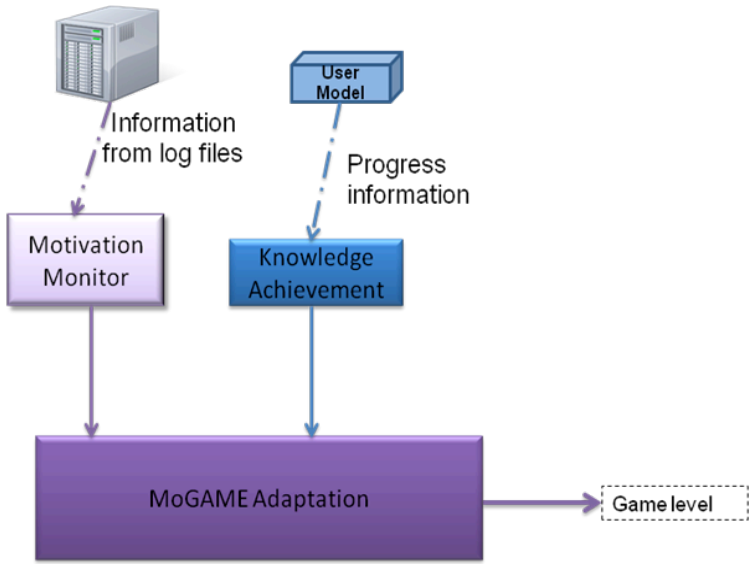

Figure 2 MoGAME's block diagram

Motivation Monitor (MM) assesses in real time various motivation related factors and determines the motivation level. This is done in two steps: regularly extracting data from the log files, and computing the motivation level. The log files provide data on the time spent reading current concept, the average time spent reading, the average time interacting with the system, the number of visited pages and the number of help requests. Information about learner's self-efficacy is collected using questionnaires.

Knowledge Achievement calculation computes the learning performance level as a function of course knowledge level and knowledge achievement speed. Knowledge level is computed by the User Model. Learning performance level is used in order to validate the motivation level, because user can just trick the system.

MoGAME Adaptation combines e-learner motivation level and knowledge achievement level. Each knowledge level will have a game level correspondence. Each game level will have four versions of the same game level: Variant1, Variant2, Variant3, and Variant4. All game versions involve the same learner's knowledge level. Variant2 differs from Variant1 just in game presentation. In Variant3 the reward received by learner is adapted according to motivation level. In Variant4, the feedback is adapted, being presenting in more details the goals and the knowledge achievement. In this way, the game level, feedback and reward will be adapted based on learner knowledge.

4 Conclusions and Future work

This paper proposed a Motivation based Game Level Adaption Mechanism (MoGAME). MoGAME makes use of e-learner motivation and knowledge level in order to adapt the game level in such a way that the game will not be too easy to bore the learner neither too hard to be impossible to be played. The aim is to gain the de-motivated learners by using rewards and reinforcing learning by goal settings.

In order to measure and assess the learner motivation in real time we proposed the Motivation Monitor. MoGAME will provide to the learner the suitable game level. Based on learner's knowledge level, the game level difficulty is selected. Also motivation is taken into consideration in order to increase learner motivation by adapting the rewards and the feedback.

Various methods for measuring e-learner's motivation were investigated. There is not clear yet which method is better to be used. Different variables are taken into consideration for measuring motivation. However, the range of their values is not clearly mentioned by the previous studies. The range value differs from course to course, and a general formula for measuring the e-learner motivation has not been proposed yet. As future work we intend to define a more general interval of possible values for each variable that will be taken into consideration for computing motivation level.

We are also planning to investigate the efficiency and the effect of MoGAME on learner's motivation and learning outcome by conduction real experiments with learners from both secondary schools and third level institutions.

Acknowledgements

This research work is supported by IRCSET Embark Postgraduate Scholarship Scheme.

References

Batson, L. & Feinberg, S., 2006. Game designs that enhance motivation and learning for teenagers. *Electronic Journal for the Integration of Technology in Education*, 5, 34–43.

Baker, Ryan. 2007.Modeling and Understanding Students's Off-Task Behavior in Intelligent Tutoring Systems. *CHI 2007. pp. 1059-1068.*

Ben-Zadok, G., Hershkovitz, A., Mintz, E., & Nachmias, R. 2009. Examining online learning processes based on log files analysis: A case study, *The Fifth International Conference on Multimedia and ICT in Education*, 1, 55-59.

Berger, F. & Müller, W., 2009. Adaptivity in Game-Based Learning: A New Perspective on Story. *Interactive Storytelling*, pp. 316–319.

Blanco, Á.D. et al., 2009. A General Architecture for the Integration of Educational Videogames in Standards-compliant Virtual Learning Environments. In *Proceedings of the 2009 Ninth IEEE International Conference on Advance Learning Technologies*. IEEE Computer Society, pp. 53-55.

Burgos, D., Tattersall, C. & Koper, R., 2007. Re-purposing existing generic games and simulations for e-learning. *Compute in Human Behavior*, 23(6), 2656–2667.

Can, G. & Cagiltay, K., 2006. Turkish Prospective Teachers ' Perceptions Regarding the Use of Computer Games with Educational Features. *Educational Technology & Society,* 9 (1), pp. 308-321.

Cetintas, S. et al., 2009. Learning to Identify Students' Off-Task Behavior in Intelligent Tutoring Systems. In *Proceeding of*

the 2009 conference on Artificial Intelligence in Education: Building Learning Systems that Care: From Knowledge Representation to Affective Modelling. IOS Press, pp. 701-703.

Chang, Y., Lu, T. & Fang, R., 2007. An adaptive e-learning system based on intelligent agents. In *Proceedings of the 6th Conference on WSEAS International Conference on Applied Computer Science - Volume 6*. Hangzhou, China: World Scientific and Engineering Academy and Society (WSEAS), pp. 200-205.

Chuang, T. & Chen, W. F., 2007. Effect of Computer-Based Video Games on Children: An Experimental Study. In *Digital Game and Intelligent Toy Enhanced Learning, IEEE International Workshop on*. Los Alamitos, CA, USA: IEEE Computer Society, pp. 114-118.

Chyung, S. Y. 2007 . Invisible motivation of online adult learners during contract learning. *The Journal of Educators Online,* 4(1).

Cocea, M. & Weibelzahl, S., 2007. Cross-System Validation of Engagement Prediction from Log Files. In *Creating New Learning Experiences on a Global Scale*, pp. 14-25.

Cocea, M. & Weibelzahl, S., 2009a. Eliciting Motivation Knowledge from Log Files Towards Motivation Diagnosis for Adaptive Systems. In *User Modeling 2007*. pp. 197-206.

Cocea, M. & Weibelzahl, S., 2009b. Log file analysis for disengagement detection in e-Learning environments. *User Modeling and User-Adapted Interaction*, 19(4), 341-385.

De Bra, P., Smits, D. & Stash, N., 2006. Creating and Delivering Adaptive Courses with AHA! In *Innovative Approaches for Learning and Knowledge Sharing*, pp. 21-33.

Ebner, M. & Holzinger, A., 2007. Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Comput. Educ.*, 49(3), 873-890.

Gee, L.P. & Lee, L.F., 2008. Motivating students to learn "Destination Geography' Through audio visual medium: Game- based Learning. In Teachers' Conference 2008. pp. 1-6.

Ghergulescu, I & Muntean, C.H., 2009. PlayLearn: Supporting Motivation through Gaming inE-Learning. 9th Information Technology and Telecommunication Conference (ITT2009).Dublin, pp. 185-190.

Hershkovitz, A. & Nachmias, R., 2009. Developing a Log-based Motivation Measuring Tool. *Proceedings of the Chais conference on instructional technologies research 2009: Learning in the technological era*, pp. 99-106.

Hunicke, R., 2005. The case for dynamic difficulty adjustment in games. In *Proceedings of the 2005 ACM SIGCHI International Conference on Advances in computer entertainment technology*. Valencia, Spain: ACM, pp. 429-433.

de Lemos, J., Sadeghnia,G.R., Ólafsdóttir, I.,& Jensen, O. 2008. Measuring emotions using eye tracking. *Proceedings of Measuring Behavior*, Online.

Little, J.K. & Page, C., 2009. Top Teaching and Learning Challenges, *Educause review. Online*.

Muntean, C.H., 2008. Improving learner quality of experience by content adaptation based on network conditions. *Comput. Hum. Behav.*, 24(4), 1452-1472.

Muntean, C.H. & MacManis, J., 2006. End-User Quality of Experience Oriented Adaptive E-learning System. *Journal of Digital Information*, 7. .

Prensky, M., 2003. Digital game-based learning. *Comput. Entertain.*, 1(1), 21-21.

Qu, L., Wang, N. & Johnson, W.L., 2005. Using Learner Focus of Attention to Detect Learner Motivation Factors. In *User Modeling 2005*. pp. 70-73

Smith, S.D., Salaway, G. & Caruso, J.B., 2009. Ownership of, Use of, and Skill with IT. *The ECAR Study of Undergraduate Students and Information Technology, 200,* 6, 41-61.

Takemura, Y. et al., 2008. Assessing the Learners' Motivation in the E-Learning Environments for Programming Education. In *Advances in Web Based Learning – ICWL 2007*. pp. 355-366.

Tran, T. et al., 2009. A Model to Manage Learner's Motivation: A Use-Case for an Academic Schooling Intelligent Assistant. In *Learning in the Synergy of Multiple Disciplines*. pp. 633-638.

de Vicente, A. & Pain, H., 2000. A computational model of affective educational dialogues. In *AAAI Fall Symposium: Building Dialogue Systems for Tutorial Applications*. pp. 113–121.

Whitton, N., 2007. Motivation and computer game based learning. Proceedings ascilite Singapore. pp.1063-1067.