A Technique to Enhance Motivational Appeal of Moodle: Design and Evaluation

Ioannis Karagiannis, Maya Satratzemi

Department of Applied Informatics, University of Macedonia, Thessaloniki, Greece
giankara@gmail.com
maya@uom.edu.gr

Abstract: Motivation is a causal factor of learning. This article presents the design and implementation of a motivational technique that builds on confidence and satisfaction dimension of the ARCS (Attention, Relevance, Confidence and Satisfaction) motivational model. The proposed technique was embedded in Moodle so as to enhance its motivational appeal by depicting student's progress in a course. However, it can be easily integrated in any other learning system as long as it is able to track learner's actions within it. In order to calculate knowledge progress, the use of two different measures is proposed: the Time-based Progress Calculation (TPC) and the Grade-based Progress Calculation (GPC). An evaluation study of a Moodle course was conducted in the context of an introductory programming course in order to examine the effectiveness of the proposed technique and students' feedback on it. Three groups were randomly formed. The first two groups had access to a different version of the course in Moodle while the third one had access only to course's webpage. The study was conducted over the first six weeks of the course, up to the mid-term exam. On completion of the respective course sections but prior to the mid-term exam, students of the first two groups had to answer a questionnaire evaluating the attended course. The questionnaire consisted of five-point Likert type questions and was divided into two subcategories: system usability and motivational appeal. The aim of our analysis was to investigate whether our motivational technique was able to stimulate students to study more, increase their motivation, and help them to improve their learning outcomes without increasing Moodle's complexity. The results were encouraging since they indicated that the implementation of the proposed technique into Moodle affected students' motivation and involvement, resulting in significantly higher grades on the mid-term exam, while their feedback about its usability was positive.

Keywords: Learning Management System, e-learning, progress calculation, motivation, ARCS model

1. Introduction

During the last decade an increasing number of educational institutions all over the world offer e-learning courses. There are many reasons for this growing tendency. One of the most important is the elimination of time, space and social restrictions since e-learning does not require physical presence of the teacher and student. Consequently, e-learning can offer equal learning opportunities to people that cannot attend a typical class, either because they work or because they live far away from universities. Furthermore, the development and maintenance of e-learning systems require less resources compared to those for a typical class. Besides their usage for distance learning, e-learning systems can also be used as supplementary material for conventional classroom education.

Many e-learning systems have been proposed in order to fulfil educational objectives and to achieve better learning results, with Learning Management Systems (LMS) playing a dominant role. These systems offer various sets of tools to support teachers in creating, administering and managing online courses. Teachers have the opportunity to: easily deliver a set of educational resources to students, create new educational resources, develop tests and learning quizzes, start over a discussion and use collaborative learning tools such as wikis, forums and chats. WebCT, Blackboard and Moodle are some of the most popular LMS which have been successfully used in many courses at universities all over the world, both for traditional and blended learning.

Although e-learning systems are widely used, their effectiveness is sometimes questioned. Selim (2007) identified eight critical success factors for acceptance of e-learning: instructor's attitude toward and control of the technology, instructor's teaching style, student motivation and technical competency, student–student interaction, course content and structure, ease of Internet access, infrastructure reliability and university support. Student motivation is the extent to which the student makes effort in and pays attention to various activities (Izmirli and Izmirli, 2015). Motivation is subjective and can be based on personal beliefs, feelings,

and/or personal preferences (Baumstark and Graf, 2014). It can be used to direct student's behaviour towards a particular goal, increase student's applied effort and energy, increase student's initiation and persistence in activities, enhance cognitive processing, and it can lead to improved student performance (Omrod, 2007). When motivation to learn is low, the potential to learn may decrease (Hodges, 2004; Wlodkowski, 1985; Yukselturk and Bulut, 2007; Keller, 1999).

The purpose of our paper is to present a motivational technique that is designed according to a specific motivational model and embedded into Moodle in order to depict student's progress in a course. This approach aims to affect students' motivation and involvement and, consequently, their learning outcomes.

The remainder of the paper is organized as follows. The next section gives a short description of ARCS (Attention, Relevance, Confidence and Satisfaction) motivational model. This is followed by a section where the design and implementation of the proposed motivational technique are described. After a section, where the evaluation study is presented, in the final section are the conclusions.

2. ARCS motivational model

One of the commonly used motivation models is Keller's ARCS motivation model (Keller, 1987). ARCS model is a method for improving the motivational appeal of a course and is based upon the idea that there are four key elements in the learning process, which can encourage and sustain learners' motivation. Each one of the above conceptual categories includes different strategies that can be applied so as to improve learner's motivation to learn.

As regards the first category, attention is an element of motivation and a prerequisite for learning (Keller, 1987). While on the one hand it is very easy to draw learner's attention, for example with a video or an animation, this is not enough. The challenge is to achieve to sustain it throughout the duration of the course. Strategies that can be used in order to draw and sustain learner's attention includes perceptual and inquiry arousal, as well as variability, such as incongruity and conflict, concreteness, humour, inquiry, and participation (Keller, 1987).

Relevance refers mainly to the clarification of the reason why students should study for their lessons. Determining learners' interests and associating their interests with instruction are among relevance strategies (Izmirli and Izmirli, 2015).

Concerning confidence, we have to mention that fear of failure is often stronger in students than teachers realize (Keller, 1987). The lack of confidence can decrease student's persistence and, subsequently, reduce learning effectiveness. Teachers, in order to improve motivational appeal of a course, must foster the development of confidence to students. They should be encouraged to attend courses regularly and to become successful in courses (Izmirli and Izmirli, 2015). Confidence strategies include learning requirements, success opportunities, and personal control, such as difficulty, expectations, attributions, and self-confidence. Clear statement of learning goals and the organization of learning materials from simple to complex are among the above strategies. Learners must form the impression that some level of success is possible if effort is exerted (Keller, 1987).

The last category of satisfaction includes strategies that can make students feel good about their accomplishments. Satisfaction strategies include intrinsic reinforcement, extrinsic rewards, and equity, such as natural consequences, unexpected rewards, positive outcomes, negative influences, and scheduling (Keller, 1987).

Based on the above assumptions, researchers consider the proposed strategies in order to develop e-learning systems with improved motivational characteristics. Usually, researchers implement some of the above techniques in the context of their learning system. Thus, the specific implementations are domain and content dependent and cannot be reused easily in other systems. Baumstark and Graf (2014) proposed a generic framework for integrating motivational techniques in learning systems according to ARCS motivational model. Recent research validates the assumptions of this model either with qualitative (Izmirli and Izmirli, 2015) or quantitative methods (Huett et al., 2008). Graf, Lachance, and Mishra (2015) proposed the design and implementation of four motivational techniques based on previous work (Baumstark and Graf, 2014). These techniques were system and content independent, and can therefore be used in any learning system and for any course. The techniques were integrated into Moodle and verified only through case studies. We propose a technique which is also system and content independent and is implemented in Moodle. Although it looks similar to the progress annotation technique mentioned above, it has a major difference. Progress annotation technique (Graf, Lachance, and Mishra, 2015) based the annotation on students' statements on whether learning objects were "completed", "in progress" and "not started". Our intention was to design a more

objective technique. Thus, progress in our approach is automatically calculated by the system based on data that are gathered through students' interaction with it.

3. Proposed motivational technique

The purpose of our paper is to present a motivational technique that is designed according to the ARCS motivational model and embedded into Moodle so as to depict student's progress in a course and, as a consequence, to affect student's involvement. In order to apply this technique we designed an introductory programming course in Moodle which consisted of five sections. In accordance with the first dimension of the ARCS model, namely the attention, which claims that variability in educational material can draw and sustain learner's attention, we decided to use seven different types of learning objects. Therefore, each section consists of: an outline, contents objects, videos, solved examples, one quiz, an open-ended question and a conclusion. Outline presents an overview of the educational objectives of the current section. Content objects present the theory of the section. In order to support flexibility during studying, we decided to segment these objects into smaller ones so that each consists of one or two of the concepts that are presented in the current section. Videos explain basic concepts of theory and provide hints for problem solving. Solved exercises consist of a description of an exercise and its solution. Quizzes include multiple close-ended questions where each one of them demands prediction of program output or filling gaps in a program. Open-ended questions include a small piece of code and learner must predict its output and reason for this prediction. Finally, conclusions summarize the main points of current section's theory.

In order to design the motivational technique according to the ARCS motivational model and embed it in Moodle, the overlay model was used so as to represent learner's knowledge progress. In this model, the student's knowledge is considered to be a subset of the expert's knowledge (Beck, Stern, and Haugsjaa, 1996). During the learning experience, the student acquires knowledge with the expectation of reaching the expert's level, yet without being able to learn anything more or anything different to him/her. In order to calculate the learner's knowledge progress, the use of two different measures is proposed: the Time-based Progress Calculation (TPC) and the Grade-based Progress Calculation (GPC).

As regards the first measure, we extended Moodle's authoring tool enabling it –apart from open-ended questions- to store for each type of learning object two different time values, namely t_min and t_max. Additionally, one more value named w is stored for each type of learning object, including open-ended questions. The t_min value represents the minimum time that is required for a learner to study the specific learning object in order for it to be considered as "known". The t_max value represents the maximum time that a learner can study it, and it prevents the system from attaining spurious results. Time values beyond this limit signify that Moodle probably is in an idle state and the learner is involved in doing something else apart from actually studying that particular learning object. Thus, if a time value exceeds t_max value, the specific time value will not be considered and the respective learning object will be considered as "unknown". Open-ended questions are considered as "known", concerning time progress, if a solution is submitted, regardless of the time that learner spent on them. The w value indicates the weight of importance of the specific learning object and it ranges from 0 to 1. The sum of w values for all the learning objects of a section equals 1. Having defined the above values, TPC of a section is defined as follows:

$$TPC = \frac{1}{N} \sum_{i=1}^{N} f(t_i) \times w_i$$

N stands for the quantity of learning objects of the specific section, w_i is the weight of importance of the i-th learning object and function f is defined as following.

$$f(t) = \begin{cases} 0, & t<t\_min \text{ or } t>t\_max \\ 1, & t\_min \le t \le t\_max \end{cases}$$

The second measure of learner's progress (GPC) refers to his/her performance on Moodle activities that can be graded. According to our course structure, such activities are quizzes and open-ended questions. Each section includes one quiz and one open-ended question. Due to the fact that the quiz consists of several questions and, thus, is more demanding than the open-ended question, we decided that the two grades would not contribute equally to GPC measurement but with different weights, 70% and 30% respectively. Therefore, the GPC of a section is defined as follows:

$$GPC = 0.7 \times grade_{quiz} + 0.3 \times grade_{open\text{-}ended}$$

In sum, the TPC for a section measures how much of section's learning material for that section is considered as known in relation to the student's effort, whilst GPC measures a learner's performance in the specific section. The student's performance is not indicated if only the TPC values are taken into account. Likewise, taking into consideration only the GPC values is unreliable because there is no evidence of the students' effort. We believe that a combination of the two constitutes an adequate way to estimate a learner's progress in a specific section. TPC and GPC are depicted in each section of the course with the help of two independent progress bars as illustrated in Figure 1.

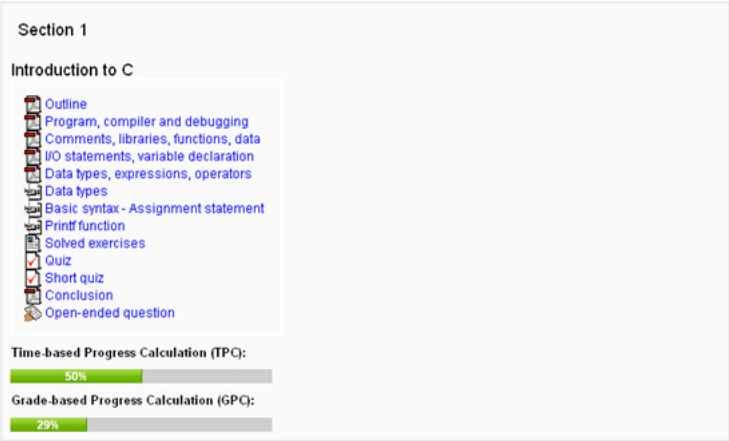

Figure 1: Screenshot of a course section in Moodle for Group 1

4. Evaluation study

In order to evaluate the effectiveness of the proposed motivational technique, we conducted an evaluation study, during the winter semester of the 2015/16 academic year in the context of the Procedural Programming introductory course, taught in our department. It consists of a 2-hour weekly lecture and a 2-hour weekly laboratory where students practice and solve a problem. Course's total length is 13 weeks. The evaluation study was conducted over the first six weeks of the course, until the mid-term exam. During this time, five sections about the fundamental concepts of procedural programming are presented to students, namely an introduction (I/O statements, data types, assignment statement), if statements, loops, functions and arrays.

Three groups of students were formed, namely Group 1, Group 2 and Group 3, based on students' preference. More specifically, after students were informed of groups' differences, they were asked to express their preference for the group they wanted to be assigned to. It should be pointed out that all students succeeded in the admission exams receiving similar grades, while studying computer science was their first choice. Consequently, they have comparable academic profiles and, therefore, it can be assumed that they are equally motivated and engaged in their studies. In addition, since the three groups were self-selecting, it is possible that those who chose to try the new method may have been more motivated and engaged in their studies already. In order to contradict this hypothesis, we investigate the three groups' average grades in a similar course which is also taught in the first semester in our department, namely "Algorithms in C". There was a slight difference between the average grades of Group 1 with a mean score of 5.94 (SD = 2.417), Group 2 with a mean score of 5.73 (SD = 2.604), and Group 3 with a mean score of 5.67 (SD = 2.093). However, none of these differences was found to be statistically significant. Thus, it can be assumed that the three groups were equally engaged in their studies and any differences in the study results were due to the proposed mechanism.

All groups attended the same lectures and laboratories whilst there were used different e-learning environments for studying and practicing. More specific, Group 1 and Group 2 used Moodle and Group 3 the course's webpage. This webpage includes the same educational material as one unified presentation, unlike Moodle where the material is organized as different learning objects. The difference between the first two groups was the way that progress bars were displayed. Students of Group 1 were able to view their progress bars for each section right after its content (Figure 1), while those of Group 2, had to request their progress bars, which were displayed in a new window (Figure 2). It was decided to use two different ways to display the progress bars in order to investigate their effectiveness. The first way (Figure 1) is more direct as it doesn't demand any additional effort in order for a student to view his/her progress bars. According to the second way (Figure 2), a student should request to view his/her progress bars and, therefore, additional effort is demanded. Moreover, a student should contemplate the bars and relate them to the respective sections. Thus, the second way increases a student's cognitive load whereas the first one directly motivates students

without demanding their mediation and is expected to be more suitable especially for first-year students, as those in our study.

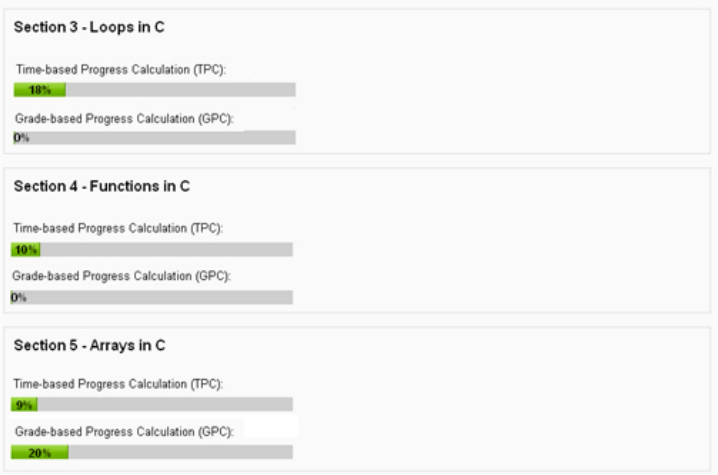

Figure 2: Screenshot of progress bars in Moodle for Group 2

On completion of the 5 sections of Moodle's course but prior to the mid-term exam, students of Group 1 and Group 2 had to answer a questionnaire evaluating the course that they attended. Finally, 234 students participated in the study and also took the mid-term exam. They were equally assigned to each group. Thus, each group consisted of seventy-eight students. The aim of our analysis was to investigate whether our motivational technique manages to stimulate students to study more, increase their motivation and help them to improve their learning outcomes on the mid-term exam.

The questionnaire was divided into two subcategories concerning two different areas of interest, namely the usability and the motivational appeal of the system. Students were asked to respond to six and five questions, respectively. The questionnaire consisted of five-point Likert type questions, ranging from 1 'strongly disagree' to 5 'strongly agree'. The findings are presented in Table 1 and Table 2 respectively.

Table 1: Student feedback on the usability of the system

Question	Group 1		Group 2	
	Mean	Standard deviation	Mean	Standard deviation
Pages loaded fast	3.9	0.896	3.9	0.831
Navigation was easy	4.2	0.858	4	0.806
Links were expressed definitely	4.3	0.851	4.3	0.839
System was user-friendly	4	0.904	4	0.856
System was considered adequate for novices	4.1	0.866	3.9	0.957
Easily familiarized myself with the system	4.4	0.868	4.4	0.787

Students' answers indicate that system usability cannot be questioned as average scores are significantly high. Moreover, results are quite similar for the two groups, indicating that system's usability is independent to the way the progress bars were visualized in Moodle. More specific, the system is characterized as user-friendly with an average score of 4 on the Likert scale for both groups. There is a slight difference between the responses of Group 1 with a mean score of 4.2 (SD = 0.858) and Group 2 with a mean score of 4 (SD = 0.806) for the item regarding 'navigation convenience'. However, this difference was not found to be statistically significant. In addition to these, students believe that system is considered adequate for novices with mean values of 4.1 and 3.9. Perhaps one of the most important findings is the last question in Table 1. Since the students that were enrolled in Moodle were on first year of their studies and, were not accustomed to the use of LMS, it would be expected that they face problems while trying to learn using the system. Nevertheless, they stated that they easily familiarized themselves with the system with an average score of 4.4 for both groups which in effect means they had a positive attitude to the system's usability. At this point it should be pointed out that there were no statistically significant differences, even for those questions that had slightly different mean values.

Table 2: Student feedback on the motivational appeal of the system

Question	Group 1		Group 2	
	Mean	Standard deviation	Mean	Standard deviation
System motivated me to study more	4.1	0.967	3.6	0.986
System helped me to learn easier	4.2	0.833	3.9	0.885
I'm generally satisfied from system usage	4.0	0.904	3.9	0.985
Visualization bars of my progress motivated me to study more	3.9	1.132	3.1	1.181
Quality of educational resources	4.1	0.622	4.1	0.574

As can be seen from the results in Table 2, all students were generally satisfied with the use of Moodle and the quality of the educational resources. Perhaps the most important finding in Table 2 is that concerning whether progress bars motivated students to study more. The average score for Group 1 was 3.9 (SD = 1.132), and for Group 2 was 3.1 (SD = 1.181), which difference was statistically significant (p-value was less than 0.05). This result confirms our initial assumption that being able to see the progress bars immediately after each section's contents is better comparatively to seeing them in a new window for all the sections. Feedback concerning system's motivation to study more and system's help to learn easier also confirmed the advantage of the first way of progress bars' visualization. The differences of the mean values for the specific questions between the two groups were also found statistically significant (U = 1679.5, p = 0.002 for the first question and U = 1890, p = 0.027 for the second one).

Regarding our final research question about whether our motivational technique improved students' grades on their mid-term exam, the equivalent findings are presented in Table 3. Before presenting these findings, it should be noted that the mid-term exam was graded out of 30.

Table 3: Student performance

	Group 1		Group 2		Group 3	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Grade	20.11	6.953	17.33	8.948	13.38	7.730
TPC (%)	61.78	27.872	32.95	27.972		
GPC (%)	61.72	28.948	41.19	33.106		

The above findings show that students of Group 1 performed better on the mid-term exam comparatively to those of the other two groups. In addition to this, students of Group 2 also achieved higher grades comparatively to students of Group 3. The average grades for the three groups were 20.11, 17.33 and 13.38 out of 30, respectively. The first step towards discovering whether these differences was statistically significant at the 95% confidence level was to apply Kolmogorov - Smirnov test so as to check if grades were normally distributed. This test revealed that normal distribution did not exist. Since t-test could not be applied, the second step was to apply two-tailed Mann-Whitney U test (u-test) to compare the grades of the groups. The results are presented in Table 4, indicating that all differences were statistically significant since p-value was less than 0.05.

Table 4: Statistical significance of grades' differences on the mid-term exam

	Group 1 – Group 2	Group 1 – Group 3	Group 2 – Group 3
U	3572.5	7902	5141.5
p	0.039	0	0.001

Furthermore, the results in Table 3 indicate that the proposed mechanism motivates students to become more actively involved in the activity as the mean score of TPC for Group1 was almost double those of Group2 at 61.78% and 32.95% respectively. This difference was statistically significant at the 95% confidence level (U = 1977, p = 0). In addition, the Mann-Whitney test applied to compare the GPC values between the two groups revealed that those in the first group had a significantly better performance (U = 2797.5, p = 0) on the Moodle

activities that could be graded (M = 61.72, SD = 28.948), compared to the second group (M = 41.19, SD = 33.106).

Summarizing the findings of the study, we come to the conclusion that the implementation of the proposed mechanism into Moodle shows a higher level of student motivation and involvement, resulting in significantly higher grades on the mid-term exam. Although one can question the validity of the findings on the basis that students' answers on feedback questionnaires may constitute a subjective point of view, TPC values are an objective measure of students' involvement and can be used in conjunction with student feedback. It should be noted that students did not receive any bonus grades for gaining higher TPC or GPC values; thus, it would be meaningless for them to attempt to deceive the system.

5. Conclusions

Students with an increased motivation to learn have a greater learning effectiveness (Dickinson, 1995). Thus, there is a need for further research evaluating learner motivation in online learning environments (Smith, 2008). Trying to contribute to research, we exploit elements from ARCS motivation model and we propose the integration of a specific motivational technique in Moodle. The proposed technique builds on confidence and satisfaction dimension of ARCS model and can be easily integrated in any other learning system as long as it is able to track learner's actions within it.

This paper presents the results of an evaluation study of the use of Moodle as supplementary material to the traditional classroom lesson. The reported findings are quite positive since they indicate that our mechanism motivated students to study more and helped them to achieve higher grades on the mid-term exam, while, at the same time, they have a positive attitude concerning its usability.

These preliminary results may provide the basis for further research in the field of motivational theory. Our future work will focus on design of other motivational techniques that will build on the other two dimensions of ARCS model, namely the attention and the relevance, so as to increase the motivational appeal of learning systems. Moreover, the proposed technique will be reviewed in order to discover potential characteristics that can be improved.

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