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Abstract

The outcomes presented in this paper are associated with the impact of motivational messages sent by a Motivation Booster to the students that participated in blended learning experiences. The aim of the Motivation Booster is to provide personalized and summarized feedback, by means of motivational messages, to the users of Computer-Supported Collaborative Learning systems on their completed collaborative learning activities. The developed Motivation Booster was integrated into the Moodle system. Two blended learning experiences were put into practice at the Universidad Pontificia Bolivariana Montería (Colombia) over an academic year with students enrolled in the course called "Software Engineering" at the Computer Science Department. A group of students participated in the first blended learning experience, and they used the Moodle system without the Motivation Booster. And another group of students participated in the second blended learning experience, where they used Moodle with the developed Motivation Booster. The experimental results give us evidences that the students felt more motivated to work with the Moodle system when they received motivational messages due to the Motivation Booster. Especially students were stimulated to work in a group manner.

Key Words: Blended learning, collaborative learning, Computer Science Education, Moodle, motivational factors, Motivation Booster.

El impacto de un Gestor de Motivación en Experiencias de Aprendizaje Mixto en Educación en Ingeniería Informática.

Resumen

Los resultados presentados en este artículo están asociados con el impacto de los mensajes de motivación enviados por un Gestor de Motivación a estudiantes que participaron en experiencias de aprendizaje mixto. El objetivo del Gestor de Motivación es proveer realimentación personalizada y resumida, por medio de mensajes de motivación a los usuarios de sistemas de aprendizaje colaborativo asistido por computador en las actividades de aprendizaje completadas por estos usuarios. El Gestor de Motivación fue integrado en el sistema Moodle. Dos experiencias de aprendizaje mixto fueron realizadas en la Universidad Pontificia Bolivariana Montería (Colombia) durante un año académico con estudiantes de la asignatura "Ingeniería de Software" de la Facultad de Ingeniería Informática. Un grupo de estudiantes participaron en la primera experiencia de aprendizaje mixto utilizando Moodle sin el Gestor de Motivación. Y otro grupo de estudiantes participaron en la segunda experiencia utilizando Moodle con el Gestor de Motivación. Los resultados experimentales nos presentaron evidencias de que los estudiantes se sintieron más motivados a trabajar con el sistema Moodle cuando ellos recibieron mensajes de motivación enviados por el Gestor de Motivación. Especialmente, los estudiantes se sintieron estimulados a trabajar de manera grupal.

Palabras Claves: Aprendizaje mixto, aprendizaje colaborativo, Educación en Ingeniería Informática, Moodle, factores de motivación, Gestor de Motivación.

1 Introduction

Blended learning is a term that refers to a variety of teaching approaches, models and initiatives where the instructors combine traditional face-to-face learning with learning activities supported by learning environments. It has great benefits over other learning alternatives (Dodero, Fernández and Sanz, 2003; Derntl and Motschnig-Pitrik, 2005; Graham, 2006).

Along with blended learning, other initiatives have been appearing in the academic context such as the collaborative learning, which is an emerging paradigm where students and instructors can interact and learn in a group manner. Besides they can create actively knowledge and sharing experiences (Pierri et al., 2012).

Additionally, several research studies had been focused in the issue of the students' motivation in the blended learning experiences (Visser et al., 2002; Keller and Suzuki, 2004; Cocea and Weibelzahl, 2007, 2009; Rienties et al., 2012). These studies indicate specifically that the motivation of some students can decrease when they execute the computer-mediated activities in the system without the presence of the instructor. Due to this issue, it is necessary that both instructors and the designers of the blended learning experiences know and apply the principles of motivation and implement motivational techniques to get better this type of learning scenarios.

The above mentioned problem has motivated us to present the current research study. In this study, it was necessary to implement an effective combination to design the proposed blended learning experiences. In this context, we advise the blend of

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face-to-face learning activities with collaborative learning activities performed by the students and the instructors in the learning management system Moodle (Moodle, 2019).

The main aim of this study is to show the impact of a Motivation Booster in blended learning experiences. This Motivation Booster was developed at University Autónoma of Madrid (Spain) (Echeverría, 2011). For this aim, we carried out two blended learning experiences with students enrolled in the course called "Software Engineering" at the Computer Science Department at Universidad Pontificia Bolivariana Montería, Colombia (UPB). In the mentioned course, the students carried out several collaborative learning activities in their final project. These activities were made as part of the collaborative project performed into the Moodle system.

The two mentioned blended learning experiences were structured in the same way. However in the first experience a group of students and their instructor (control group) used Moodle system without the Motivation Booster and in the second experience the Motivation Booster was integrated to the Moodle system that was used by a group of students and their instructor (experimental group).

In this manner, the impact of the Motivation Booster was evaluated through the contrast among students' interactions in the activities affected by the booster in the experimental group with respect to the students' interactions in the control group without the Motivation Booster.

The paper is structured as follows. Next, we present the related work. Section 3 is a description of the implemented Motivation Booster in the Moodle system. In Section 4 we explain the research methodology used to carry out the research experiences. Section 5 contains a discussion of the details of the blended learning experiences and their experimental results. Finally, the paper ends with some conclusions and future research issues (Section 6).

2 Related Work

In this section we present some approaches, experiences and models in employing blended learning to Computer Science Education. Additionally we present the principles of the Motivation in learning environments in terms of its definitions and motivational models.

2.1 Blended Learning Experiences

The term blended learning has been defined in 2006 by Graham as "The combination of instruction from two historically separate models of teaching and learning: traditional face-to-face learning systems and computer-supported learning environments" (Graham, 2006).

The blended learning systems intend to overcome the failures of e-learning systems: most current e-learning approaches focus on solving digital content management problems and neglect learning processes and theories. Besides instructors on e-learning systems have to develop social, teaching and technical skills. In this respect, some instructors do not have the time, knowledge or motivation to use e-learning systems.

There are several different reasons for executing blended learning experiences in both academic and corporate fields. According to several researchers there are three important reasons for selecting a blended learning experience instead of other learning options (Derntl and Motschnig-Pitrik, 2005; Graham, 2006).

Firstly, blended learning experiences help to implement teaching practices more effectively. Blended learning intends to solve some of the problems of the face-to-face learning model, such as, the mere transmission of knowledge, specifically when the instructors transmit the knowledge and the students do not participate in an active way.

Secondly, the accessibility and flexibility are very important factors in blended learning, because the students can combine the flexibility of computer-supported learning environments with the social interactions in the face-to-face model. This flexibility is associated with the fact that the students and instructors can interact through the learning environments without neither time nor space constraints.

And finally the blended learning experiences provide universities and companies with economic benefits because they offer the opportunity to obtain a large return on investment. Moreover, the costs of several elements in particular, such as physical infrastructure, technological resources, etc. are decreased.

There are several studies that corroborate the use of blended learning as a successful approach. An example is the research study developed at the University of Rijeka, Croatia where a blended learning model was used as a mixture of collaborative learning, problem-based learning (PBL) and independent learning, in a "Teaching Methods in Information Science" course. This model was implemented as a combination of a face-to-face environment and online learning using a learning management system called adaptive hypermedia courseware (AHyCo) (Hoic-Bozic, Mornar and Boticki, 2009).

Other study presented in (Alonso et al., 2011) showed the evaluation of a blended learning approach in a software engineering related course unit as part of an undergraduate engineering degree program in computing. The aim of this research study was to decrease the underachievement and the high course unit dropout rate in the past courses. The results of this experience showed the effectiveness of the new system deployed compared to the lecture-based system previously (Alonso et al., 2011).

Additional to mentioned studies, there are several models and initiatives to develop blended learning experiences.

The BLESS (blended learning systems structure) model was developed as a framework for mining, applying, evaluating, and improving blended, person-centered learning scenarios. This model is integrated by six layers: i) learning theory and didactic baseline: it sets the overall educational targets, resulting interpersonal attitudes, the delivers requirements and constraints on the technological solution; ii) blended learning courses: it applies the didactic orientation defined in the previous layer; iii) course scenarios: it provides conceptual models and visualizations of scenarios by modeling their sequences as activity diagrams in the standard Unified Modeling Language (UML) notation; iv) blended learning patterns: they include online knowledge gathering and construction in groups, publishing of electronic content and interactive elements; v) web templates: it shows parameterized and interactive web pages; and vi) learning platform: it contains the web templates and the included patterns (Derntl and Motschnig-Pitrik, 2005).

The teaching system called BLOSSOMS (Blended Learning Open Source Science or Math Studies) is an initiative to develop free repository of blended-learning video modules for high school math and science classes, created by gifted volunteer educators from around the world. These modules were designed to offer learning exercises that will enhance critical thinking skills and retain students' interest in math and science. The high school BLOSSOMS initiative is conducted by the following considerations: i) technology is changing education; ii) the Open Educational Resources (OERs)

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are free learning materials; iii) the World is creating major environments on the web; iv) many high school students, are turned off to studying math and science; v) the instructors in high schools need appropriate technology; vi) generally the teaching of mathematics in high schools is done formally. And vii) the motivation can increase the numbers who will select engineering, science and mathematics as career goals (Larson and Murray, 2008).

2.2 The Motivation in Learning Environments

According to some researchers there are different definitions of motivation, we present below two of them:

Motivation is an internal state or condition that serves to activate or to energize the human behavior. The sources of the motivation can be internal: interest, enjoyment, etc., or external: get a degree, fear of punishment or sanctions, among others (Weiner, 1985; Graham and Weiner, 1996; HersX hkovitz and Nachmias, 2009).

Motivation is the magnitude and direction of the behavior. In other words it refers to the decisions that people make about the experiences that they do or avoid, and the degree of effort made in this direction (Keller, 1983, 2008).

The motivation is very complex. More specifically, the students' motivation in learning environments is of scientific significance. Some authors use the concept of "motivational factors" to analyze a set of theories, studies and models to improve students' motivation (Keller, 1983, 2008; Weiner, 1985; Cocea and Weibelzahl, 2009; Figas, Hagel and Bartel, 2013; Naves et al., 2013; Muñoz-Merino et al., 2014).

In the literature reviewed we found that the motivational design models can be categorized into four groups: i) person-centered models; ii) environmentally-centered models; iii) interaction-centered models and iv) omnibus models (Keller, 2008). Nowadays, interaction-centered models are probably the most used in the study of human learning and motivation in an educational field. Some examples of this type of models are the Wlodkowsky model (Wlodkowski, 2010) and the ARCS model (Keller, 1983, 2008).

The Wlodkowsky model provides an approach that includes a large number of motivational factors. This model divides motivational strategies into six categories: attitudes, needs, stimulation, affect, competence and reinforcement (Wlodkowski, 2010).

And the ARCS (attention, relevance, confidence and satisfaction) model has a complete motivational design process for developing motivational strategies.

We based our research on the ARCS model because this has been tested and accepted as a successful one for implementing applications on motivational interventions as discussed in (Keller, 2008).

The ARCS model has four components: attention, relevance, confidence and satisfaction. Each component is associated with the "principles of motivation to learn" defined in (Keller, 1983). Additionally, each ARCS component can be used to determine the students' motivational factors that need to be identified in order to improve their motivation to learn.

3 The Motivation Booster

In this section we present the description of the Motivation Booster and the description of its implementation in Moodle system.

3.1 Description

The Motivation Booster was implemented by developing software components that analyze the interactions of the students with the system and then give feedback information to the students and instructors. This information associated with the collaborative learning activities carried out by the students are motivational messages. Every message is a congratulation or a recommendation message depending on the progress the collaborative learning activities that the students have completed. They are showed in two ways: on-line and out-of-system.

On-line: The system displays through a graphical user interface motivational messages to the students and instructors about the progress of the collaborative learning activities.

Out-of-system: the motivational messages are sent via e-mail.

The general Motivation Booster architecture is based on a Web server framework, composed of five interconnected elements:

The activities repository: stores the script implemented by the instructor. S/he defines the collaborative learning activities that are performed by the students while interacting with the system.

The data model: contains the information about students' interactions with Moodle system. This information is stored in the database or in the system log files.

The data processing service: receives and processes the statistical reports on the activities performed by the students.

The trigger rules manager: is based on two types of general rules: i) rules related to learning activities completed in due time, and ii) rules related to sequence of learning activities. The trigger rules manager is able to generate the congratulation and recommendation messages.

The feedback information service: displays on-line motivational messages, and sends the same information via e-mail (out-of-system).

3.2 Description of the implementation in Moodle

Moodle can be distributed through GNU licensing. The word Moodle was originally an acronym standing for modular object-oriented dynamic learning environment. This tool is extremely useful for educational programmers and scholars (Moodle, 2019).

This software can be used to create Internet-based courses and websites where instructors and students can interact. Moodle can be employed not only to prepare but also to teach such courses, because this platform also provides administration and communication tools. Moodle is not a full collaborative system; however, in the present study we have selected it as a system to support collaborative learning activities because Moodle has been widely used in university courses. Furthermore this system provides standardized components to add new functionalities (Garcia-Penalvo et al., 2011). These components are modules and plugins embedded in the system. Moodle supports different kinds of plugins.

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The modules and plugins provide the main tools to support learning activities in Moodle using the educational resources. The instructor can select the tools that he or she needs to use in a specific course such as: forums, chats, messages services, etc.

As we mentioned, Moodle is not a collaborative system. Nevertheless we have added functionalities of collaborative learning to this system. For this purpose, we have selected a previous module in Moodle called "database activity module". This module only supports interactions between students and instructor. And from the previous module we have developed a new module to assist additionally students-to-students interactions. This new activity module allows for the instructor and/or students to perform and display different collaborative tasks about any topic. Three specific tasks in the developed module were implemented: i) build an entry (one entry is defined like a document added by the students and the instructors into the system); ii) make comments on classmates' entries and iii) rate other classmates' entries. Additionally, we designed a "block" plugin to implement the Motivation Booster as an innovative feedback information service. It is important to remark that the Moodle Relational Schema was modified. More details about the implementation of the Motivation Booster in Moodle are in (Echeverría, 2011; Echeverria, 2017).

4 Research Methodology

This section proposes a methodology to perform blended learning experiences in Computer Science Education. The methodology was tested with students from a Software Engineering course. However it could be used with other courses. The research hypotheses, the participants, instruments and procedure of the study are presented.

4.1 Hypotheses

H1: The motivational messages sent by the booster affect the students' interactions when they perform the collaborative learning activities. Specifically, these messages can increase the interactions with the system.

H2: The motivational messages help to determine the students' motivational factors.

4.2 Participants of blended learning experiences

Two blended learning experiences were put into practice at the UPB-Montería (Colombia) over an academic year with students enrolled in the course called "Software Engineering" at the Computer Science Department. Seventeen students (control group) participated in the first blended learning experience, where they used the Moodle system without the Motivation Booster. Sixteen students (experimental group) participated in the second blended learning experience, where they used the Moodle system with the Motivation Booster implemented.

4.3 Instruments

In this study, the students' interactions were analyzed, which are the dependent variables recorded in the system. Besides, one individual questionnaire was applied to students that participated in the experimental group. The aim was to know the students' motivational factors when they received the congratulation and the recommendation messages. These data allowed us to analyze the impact of the Motivation Booster in the blended learning experiences and to draw these factors.

The students' motivational factors in this study are assigned to the ARCS components in each type of message. These motivational factors have been developed conceptually in (Echeverría, 2011; Echeverria, 2017) and they have been tested empirically.

Regarding congratulation messages, the impact of the Motivation Booster was evaluated considering three motivational components of the ARCS model: relevance, confidence and satisfaction. From these components were measured nine students' motivational factors:

The motivational factors related to the relevance component are: i) the student feels his/her performance improved, ii) the student feels involved in collaborative activities and iii) the student feels interested in the content.

The motivational factors related to the confidence component are: i) the student feels s/he is achieving his/her goals, ii) the student feels self-assured and iii) the student feels successful.

The motivational factors related to the satisfaction component are: i) the student feels his/her work is recognized, ii) the student feels treated fairly and iii) the student feels enthusiastic.

Regarding the recommendation messages, the impact of the Motivation Booster was evaluated considering three motivational components of the ARCS model: attention, relevance and confidence. From these components were measured nine students' motivational factors. The motivational factors related to the relevance component and the confidence one are the same motivational factors mentioned above.

The motivational factors related to the attention component are: i) the student feels always informed, ii) the student feels mentally stimulated and iii) the student feels curiosity.

4.4 Procedure

The same instructional script was proposed in the two mentioned experiences. On the one hand, the students spent four hours per week in traditional face-to-face learning. And on the other hand, the students and instructors used the Moodle system across all the blended learning experiences to complete the collaborative learning activities in several topics. The instructors advised students to use the system for two hours per week to complete these activities.

The activities scripted by the instructors and performed by the students were: i) build an entry, ii) write comments on classmates' entries, and iii) rate other classmates' entries. From these activities, three variables related to students' interactions were defined in Moodle: i) total number of submitted entries, ii) total number of submitted comments and iii) total number of submitted ratings.

5 Results and Discussions

The collected quantitative data in this study consisted of, first, the values of the students' interactions recorded in the system; and second, the students' responses to the questionnaire related to the congratulations and the recommendation messages (it was applied to the experimental group). The data were analyzed using statistical analysis. The analysis of variance (F-Test) was done to check the difference in samples from the two experiences. Besides the T-Test was used to compare the means between the values of the students' interactions in the system (inferential statistics). Finally

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the values of students' motivational factors were analyzed to determine the impact of the Motivation Booster.

The result of the analysis of variance (F-Test) showed that the two blended learning experiences (Control group and experimental group) had no statistical significance with respect to the total number of submitted comments (F = 0.9277, p-value = 0.8802) and the total number of submitted ratings (F = 1.3651, p-value = 0.5519).

The T-test confirmed us the increase of the students' interactions of the experimental group. This test showed us that the outcomes of the two blended learning experiences were statistically different from each other. There is a big difference between the values of the means of: the total number of submitted comments (p-value= 0.0009136) and the total number of submitted ratings (p-value= 0.00005925).

It was possible to corroborate that the motivational messages helped to increase the number of the students' interactions with Moodle.

This allowed us to conclude that the students of the experimental group were more motivated, especially when they wrote on classmates' entries, and when they rated other classmates' entries. Therefore, the first hypothesis (H1) is corroborated.

Additionally, the results of the questionnaire let us to know about the students' motivational factors. The Table 1 presents these results associated with the congratulation messages. The most representative students' motivational factors were: a) the student feels his/her performance improved, b) the student feels successful and c) the student feels his/her work is recognized. This showed us that if the motivational objective is to increase the students' relevance, then it is important that the students receive congratulation messages. Specially, these messages should emphasize that the students' performance has improved.

Otherwise, if the motivational objective is to increase the students' confidence, then the congratulation messages sent by the booster should definitely highlight when the student is successful. Finally, if the objective is to increase the students' satisfaction, then these messages should also help to value the work performed by the students in the system.

Table 1. Motivational Factors related to Congratulation messages. The student feels ...

Relevance	%	Confidence	%	Satisfaction	%
his/her performance improved	50	he/she is achieving his/her goals	22	his/her work is recognized	46
involved in collaborative activities	21	self-assured	21	treated fairly	16
interested in the content	29	successful	57	enthusiastic	38

The Table 2 presents students' motivational factors related to recommendation messages. In this case the most representative students' motivational factors were: a) the student feels mentally stimulated, b) the student feels his/her performance improved, and c) the student feels he/she is achieving his/her goals. This showed us that if the motivational objective is to increase the students' attention, then it is im-

portant that the students receive recommendation messages. These messages should keep the students mentally stimulated. Likewise, if the objective is to increase the students' relevance, then the recommendation messages should emphasize that the students' performance has improved. Finally, if the objective is to increase the students' confidence then these messages should absolutely underline that the students have achieved their learning goals in the system. Therefore, the second hypothesis (H2) is corroborated because we have detected the motivational factors due to the congratulations and recommendation messages.

Table 2. Motivational Factors related to Recommendation messages. The student feels ...

Attention	%	Relevance	%	Confidence	%
always informed	31	his/her performance improved	54	he/she is achieving his/her goals	46
mentally stimulated	57	involved in collaborative activities	23	self-assured	16
curiosity	12	interested in the content	23	successful	38

6 Conclusions and Future Work

The current work presents a research study about the use of a Motivation Booster integrated into the Moodle system. This Motivation Booster was developed at University Autónoma of Madrid (Spain) (Echeverría, 2011; Echeverria, 2017). The developed booster delivers the students and the instructors with on-line feedback information through the addition of a new service in the Moodle system. Furthermore, it provides out-of-system information by means of electronic mail messages. This feedback information is presented in motivational messages. There are two types of motivational messages: congratulations and recommendation ones.

In this study two blended learning experiences were performed using Moodle (Control group and experimental group). The Motivation Booster was not used during the first experience in Moodle system (Control group). Whilst in the second one (Experimental group) the booster was employed to send motivational messages to the students while they finalized the collaborative activities. The aim of both experiences was to find out the students' interactions in the system. Moreover the students' motivational factors were discovered in the second one (Experimental group).

Additionally, we have created a research methodology for performing the mentioned blended learning experiences in Computer Science Education courses. Besides, we used the ARCS model. The aim of this motivational model is to apply us the elementary fundaments of students' motivation to learn when they use a Learning Management System.

The experimental results provided evidence to corroborate two research hypotheses. Firstly, the students raised their number of interactions performed in the second experience (Experimental group). This let us assume that the students felt

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more motivated to work with the Moodle system when they received motivational messages. Especially students were stimulated to work in a group manner.

Secondly, the congratulation messages sent by the Motivation Booster made the students feel that their performance improved, successful and their work was recognized. It showed us that the congratulations perceived by students had a strong effect in their intrinsic motivation. Particularly, when they feel that their work is highly valued by the instructors and their fellow classmates.

Likewise, the recommendation messages made the students feel mentally stimulated, their performance improved and they were achieving their goals. In this case, we concluded that the recommendations received by students helped to increase their extrinsic motivation. Mainly, when the students stayed mentally stimulated they were able to achieve their goals in an enthusiastic manner.

As future work, we propose to improve the implementation of the Motivation Booster. For this purpose, we will define a pattern of rules. This pattern will be based on several criteria to improve both the product and the students' learning process. The new general rules will be embedded in the Motivation Booster.

Finally, we are testing the implementation doing other research studies with students and instructors from Computer Science Education with the aim to confirm the obtained outcomes and besides to corroborate the hypotheses presented in the current research study.

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