# Impact of Moodle usage practices on students' performance in the context of a blended learning environment

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*Abstract*— **In this paper, students' practices and performance were studied, while using a Learning Management System in a blended learning environment. This is a case study involving 117 students who attended an academic course based upon a blended learning approach, using an open source e-learning environment (Moodle). The course refers to ICT integration in education and has been reformulated to be offered in the context of blended learning. The course's methodology was mainly based on a problem solving approach. The impact of nine variables depicting the expressed students' practices while using Moodle was examined (spectrum of use, assignment view, forum add post, forum view, resource view user's profile inspection, questionnaire and glossary inspection) on their performance. A multiple regression was applied to investigate relation between the students' practices and their performance. From the analysis of the collected data it was depicted that the system usage is significantly related with the students' performance, explaining the 20.2% of variance in their total grades.**

*Index Terms*— **Blended Learning Environment, Moodle, log files, practices, student performance.**

## I. INTRODUCTION

During the recent years, a significant volume of research on the effectiveness of the use of ICT in Education in general and the integration of Learning Management Systems (LMS) in particular, have been realized. In the latter, a series of important questions emerge, mainly related to the study of the appropriate teaching methods, the effective design of technological infrastructure and the design of the interaction of students with the system. The last dimension depends largely on the earlier *attitudes* and *perceptions* of the learning community's members like students and teachers.

The Learning Management Systems (LMS) are technological learning environments that support online course delivery. They offer comprehensive synchronous and asynchronous services, and also support collaborative learning. As a result, they play an important role in distance education and are increasingly adopted in the context of typical education.

The main feature that differentiates the ODL systems from the 'traditional' learning environments is the degree of technology usage and the gradual shift of control and responsibility of the learning process to the learners, giving them the opportunity to learn anytime, anywhere. This shift of control of the learning process to the learners seems to positively influence their learning effectiveness [1]. The objective of a LMS system is (a) to bridge the distance between the learner and the provided learning material and (b) to embed social interactions within the same environment, thus providing to the learners the opportunity to become active participants and not mere receivers of information. In this context, sociocultural theories influence considerably the learning procedure and have strengthened the perceptions of the educational community towards adoption and effective integration of ODL system in the educational process.

This trend runs across all levels of education, while at the same time a significant use in higher education is observed [2]. Usage of those technologies produces new teaching practices and paradigms such as mixed models of traditional learning like *blended learning* [3], in order to effectively combine the advantages of the real and virtual class simultaneously. However, design and application of a mixed model of learning is not a straightforward task and requires significant modifications of the course's learning framework. Important predictors of the quality of the learning experience are the *amount and the quality of interaction* and the *sense of commitment* to a community of inquiry and learning. Those could be achieved through the effective integration of technology while at the same time exploiting the advantages of a traditional course that includes lectures and meetings [3].

The development of a mixed model of learning is a complex process of transforming an existing educational framework based on the following factors [4]: (a) the context of the lesson should be presented through problem solving scenarios, (b) development of appropriate materials and resources, (c) adjustment of platform's tools to the demands of the problem solving paradigm, (d) inherent support of active participation for all members of the learning community, while transforming the role of teachers to cooperators. The blended learning appears to be a successful combination of different teaching and learning methods, with the subsequent development of innovative methods for material production, course conduct

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and therefore the teaching results [5]. This mixture concerns both a variety of network technologies and pedagogic theories, but mostly concerns and requires their effective combination [6] in order to make use of the advantages of virtual and real class at the same time. This effort focuses on the quality and the quantity of interaction and also on the perspective of the participants' commitment to the learning community [7].

In the aforementioned context, critical parameters, that affects significantly the benefits of an ODL, are the attitudes and perceptions of users about them. The formulation of these concepts depends mainly on four factors: the *people's characteristics* (such as earlier knowledge and effective use of tools), the level of *social support* and *interaction* that users experience, the *organization* of the technical characteristics of the system and the course's learning content and the *characteristics* of the institution and the overall *attitude* and *policy* towards ICT [2].

As derived from the previous discussion, a systematic investigation and understanding of concepts, attitudes and practices involved in a blended learning process will contribute to deeper knowledge acquisition, facilitating the design of effective learning interventions and ODL environments. The aforementioned goal could be achieved by a systematic investigation of learners' beliefs, and attitudes while been enrolled in a distant learning course. The *beliefs* are a psychological state in which a person believes that an object or a situation is true or that it is a 'general' truth. Beliefs are conceptually different from the entity of knowledge, since knowledge is a social, partially validated construction. On the other hand beliefs are entirely individual structures. However, beliefs are expressed as knowledge from the subjects who believe in them. The *concepts* are complex operations by which a person acquires knowledge of the reality either directly to the senses, or indirectly by the intervention [8]. The term "practices", refers to all the different uses that students of LMS are carrying out, during their participation to a course.

Recent studies showed that the degree of the ODL's acceptance by the learners is important [9]. The main advantages, as perceived by them, seem to be usability, accessibility, flexibility and interaction with the system. On the contrary, the limited nature of the interaction between learners and teachers often influences negatively the expected learning outcome [9]. Valuable time was also reported to have been spent in order to retrieve store and print the electronic material. Furthermore, it seems that familiarity with Internet technologies is a strong positive predictor of the ODL's acceptance [10]. In addition, the students' attitudes towards usage are substantially affected by the perceived functionality of the system [11]. It is also suggested that the learners' perceptions of ODL as a means of distant learning are no different than the learners' perception of ODL as a complementary tool for teaching a lesson in the context of a blended learning [11].

As far as the expressed usage practices are concerned, 3 categories were distinguished [12]: mastery oriented users,

task focused users and minimalist in effort users. Reference [12] identified the aforementioned usage patterns, through processing and meaning extraction of quantitative usage data, such as total time of use, usage spreading, times pan across reconnection in the ODL system, intensity of interaction and amount of communication with other learners and/or teachers. Regarding the level of expertise expressed by the students while using the system, often they are distinguished into three distinct groups (the inadequate users, the moderate users and the highly skilled users) [13], [14]. However, excluding the aforementioned efforts, a lack of sufficient studies related to the students' practices and performance in blended learning environments was observed in general.

The goal of the study presented in this paper was to investigate the design, development and evaluation of a university undergraduate course using an asynchronous ODL. In particular, the aim of this study was to investigate course attendants' expressed practices. The relation of measured aspects of learners' practices with their rated performance was also studied. The presented work was primary inspired by the theoretical constructs presented previously. The rest of the paper is organized as follows: First, the method of the study, followed by the analysis of the results and the interpretation of the findings, is presented. Finally, the results and their possible implication are being discussed thoroughly.

## II. RESEARCH METHODOLOGY

### A. Research objectives

The goal of the study was to identify the factors that influence students' performance while using an ODL platform, in particular the Moodle system, in the context of a blended learning University course. The objectives of the study were a) to investigate possible relations of students' practices, as represented using a variety of interaction metrics, with their performance and b) to specify which of the students' interaction metrics practices were strongly related to their performance.

117 University students of the Department of Educational Sciences and Early Childhood Education, University of Patras, participated in the study. The students attended a compulsory 2$^{nd}$ year course offered in the context of a blended learning approach using Moodle. The course concerning the integration of ICT in Education took place the second semester of the academic year 2008-2009.

A case study approach was adopted, for the implementation of the research [15]. The materials and the didactic approaches used in the course were gradually reformed from March until July 2007, in order to be suitable with the adopted blended learning approach. The course's laboratory session was adequately adopted at first, followed by the reshaping of the course that geared primarily to the laboratory part of the course. The LMS used for this purpose was Moodle and the courses' content is available at http://150.140.160.60/moodle/course/view.php?id=30.

*B.  Procedure*

The course entitled "Information and Communication Technologies in Education" was held in the spring semester of 2009. In particular, the students attended a two-hour compulsory laboratory session for 11 consecutive weeks. Each session dealt with a particular topic, related to the goals of the course. For each laboratory session, except the first two introductory sessions, the students had to deliver a personal report after solving a problem based assignment. During each lab the tutors provided information about the topic and the goals of the session and subsequently explained each assignment given to the students. The materials provided to the students were organized according to each subject and were available to the students until the end of the semester.

Design and delivery of the course was based on a social constructivist pedagogical framework. A number of principles of the blended learning [3] were also adopted with respect to the goals and the context of the course, as described below. In addition, face to face characteristics and online technologies (Moodle) were utilized. The adopted pedagogical model was based on the problem based learning approach proposed by [16]. The proposed approach was characterized by the following principles:

● During the workshops, the students were initially exposed to a problematic situation but not to the related material. In this context, students were forced to anticipate the required concepts and skills to tackle the problem presented to them. By reflecting upon the problems, they internalized the need to learn throughout the process to solve the problem. Each week individual projects were assigned to the students, followed by lab sessions and lectures.

● Concerning the didactic goals, students were informed at the beginning of each lab session for the problem's goal and the skills that they were expected to acquire. By using this approach, it was expected to minimize the possibility of any disorientation the students may experience towards their effort to solve the given problem.

● Emphasis on selecting the appropriate resources for effective problem solving was given. In order to help students tackle the given assignments, a variety of related resources was offered to them via the Moodle system. In addition, the course's instructor and two teaching assistants were available providing insight and further clarifications to central concepts, upon request. Such guidance was provided via face to face collaboration with the assistants or by suitable questions posted at the Moodle's forum. The online resources provided to the students were of complementary type and were delivered in various formats, such as web pages, slides and software online (animations, simulations, interactive hypermedia, encyclopedias, glossary exercises, etc.) pdf documents, analysis grids and self-assessment modules online, but printed resources are usually neglected. A

glossary comprising definitions for each new concept entity was also provided.

● An important goal of the adopted LMS was to enhance collaboration among students and instructors. The technological environment could create an active learners' community outside the strict context of the class. However, in order to enhance the learners' sense of ownership, the students were asked to provide individual project reports, thus providing their own solutions.

● The goal of the requested projects was mostly related to the creation of suitable learning activities for the kindergarten, using a variety of educational software, or to assess their quality in various dimensions (e.g suitability for learning in specific contexts, technical and interaction quality, using evaluation rubrics).

● According to the requirements of each weekly project, the deliverable was a combination of written essays, software files implementing the requested activity (such as concept maps), powerpoint presentations and completed evaluation rubrics. The students were graded by their deliverables for the laboratory (50%), and a final written examination (50%).

*C.  Data collection*

The procedure used for the data collection and the analysis is described in [17] and comprises 4 phases: 1. data collection, 2. preliminary data preprocessing using appropriate algorithms with respect to the research questions, 3. application of the method (implementation of algorithms for carrying out the results), and 4. interpretation of results and conclusions.

The types of data gathered were learners' interaction log files, which were extracted from the Moodle and students assignments. The process of extraction meaning from learners' log files was carried out using a tool developed by the authors to collect and preprocess the data. Subsequently, the data were inputted in SPSS (V. 17) for statistical analysis.

*D.  Data analysis*

For the data analysis, the collected users' activity data were analyzed through a preprocessing and meta-analysis tool, developed by one of the authors. Subsequently, data collected from the logs of the users' actions, the students' worksheets and their exam papers, were coded in a table of categorical and numeric variables. Initial data inspection showed that the learners' observed behavior could be described by two categorical variables, according to the total usage for each day and the total number of steps carried out by each user per day. The study of the recording log files led to the construction of the variable "spectrum of use" of the system in a weekly basis". For the *"spectrum of use"* variable, the information related to the users' entrance to the Moodle (date and time of entry), was recorded. Week long intervals were determined and a new variable emerged (with values ranging from 1: "once a week" to 3: "every day"). From the log files, a series of numeric variables depicting the system's usage in general and the frequency of accessing each service in specific, was

also collected: ***total actions***: indicating each user's total actions while using the system throughout the semester, ***assignment view***: related to the recorded low level actions that the users carried throughout the assignment module, ***forum add post***: indicating forum posts by each user, ***forum view***: the total recorded actions related to the forum inspection, ***glossary view:*** indicating how many times a student used the glossary ***questionnaire view:*** the numerical data related to the recorded questionnaire inspection (which allowed users to complete online style forms using a variety of user input methods), throughout the semester, ***resource view***: indicating the number of low level actions that each student carried out, to access and study the provided learning material, ***user view***: related to the recorded actions that the users carried out in the entirety of the users profile inspection, ***user view all***: related to the recorded actions that the users carried out in the entirety of the all users profile inspection. From the assessment of the students' laboratory worksheets and their exam papers, the final grade for each student was calculated.

## III. RESULTS

From the analysis of the log files (86435 records in total) it was observed that the majority (79 out of 117, 67.5%) of the students, used the Moodle 3-4 times per week (Table 1). A significant variation concerning the amount of students' accesses to the Moodle platform was also depicted. However, most of the students expressed moderate to high usage frequency.

TABLE I.          SYSTEM USAGE

| Spectrum of use | |
| --- | --- |
| Every day | 24 (20.5%) |
| 3-4 times per week | 79 (67.5%) |
| 1 time per week | 14 (21.4%) |
| **Total** | **117 (100%)** |

Regarding the students' performance: 14 (11.96%) students failed to pass the lesson, 10 (8.54%) received a passing degree, 61 (52.13%) performed very good and 32 (27.35%) received an excellent grade.

A multiple regression was used to identify possible relation between the students' performance and the variables expressing system usage. A total of 9 independent variables were considered as predictors for the multiple regression modeling. The total number of actions for each student while using the system is represented by the independent variable "total actions". However, since it is significantly correlated with the majority of all the other variables, it was excluded from the analysis [18]. A multiple regression analysis was applied to identify the impact of the remained independent variables to the dependent variable.

Since multiple regression analysis requires the use of numeric and boolean variables only, the variable spectrum of

use was recoded accordingly using two dummy variables (low use and moderate use) [18].

Thus, the independent variables were ***spectrum of use (low use and moderate use)***: with values ranging from 1: "once a week" to 3: "every day" which were suitably attributed to the introduced dummy variables: for spectrum of use=1, low use was coded as 1 and moderate use as 0, for spectrum of use=2 or 3, low use was coded as 0 or 1 and moderate use as 1, accordingly, ***assignment view***, ***forum add post, forum view***, ***glossary view, questionnaire view, resource view, user view*** and ***user view all***. The dependent variable adopted was the students' ***Final Note*** (with values ranging from 0-10).

TABLE II.          MEAN SCORES AND STANDARD DEVIATIONS FOR EACH VARIABLE (N=117)

| | Mean | Std. Deviation |
| --- | --- | --- |
| Final_Note | 7.111 | 2.1306 |
| Spectrum of use | 2.08 | 0.589 |
| assignment_view | 96.85 | 35.142 |
| forum_add_post | .21 | .539 |
| forum_view | 18.15 | 16.126 |
| glossary_view | 5.85 | 12.629 |
| questionnaire_view | 153.39 | 95.140 |
| resource_view | 129.66 | 55.749 |
| user_view | 15.73 | 17.357 |
| user_view_all | 13.99 | 22.687 |

Referring to the dependent and to the independent variables of the study (Table 2), the mean values and the standard deviations are: Final Note: mean value is 7,111 (SD= 2.1306), Spectrum of Use: 2.08(0.589). Assignment view 96.85 (35.142), Forum add post: 0.21(0.539). Forum view: 18.15(16.126), Glossary view: 5.85(12.629), Questionnaire view 153.39 (95.140), Resource view: 129.66 (55.749). User view 15.73 (17.357), User view all: 13.99 (22.687).

A linear relation between independent (predictor) and dependent (criterion) variables is assumed. SPSS 17 was used for the data analysis. Only regression coefficients (b-weights), which describe the relation between a predictor and a criterion, with a significance of $p < 0.05$ were considered.

The relation between Moodle usage in students' performance was estimated by the method of ordinary least squares using multiple regression analysis. The basic unit of analysis was each individual student. The goal was to examine the students' performance variation in their course attendance, according to their logged system usage.

The multiple regression analysis resulted in a model that explains 20.2% of the students' performance. Three out of nine independent variables were found to be significant correlated with the dependent variable, F = 2.679, p= 0.006< 0.01, adjusted $R^2$ =0.126. The three independent variables found to be significantly correlated were: (a) ***moderate use***, $\beta$ = 0.389, p= 0.013< 0.05 (b) ***questionnaire view***, $\beta$= 0.255, p = 0.030 <0.05 and (c) ***glossary view***, $\beta$= 0.206, p=0 .049 <0.05 (Table 3).

TABLE III.    SUMMARY OF REGRESSION ANALYSIS FOR FACTORS PREDICTING FINAL NOTE

| Model | B | Std. Error | Beta | t | Sig. |
|---|---|---|---|---|---|
| (Constant) | 4.770 | .758 | | 6.292 | .000 |
| low_use | .892 | .696 | .195 | 1.281 | .203 |
| **moderate_use** | 2.545 | 1.006 | .389 | 2.530 | .013 |
| assignment_view | .002 | .008 | .040 | .317 | .752 |
| forum_add_post | -.022 | .393 | -.006 | -.057 | .955 |
| forum_view | .000 | .018 | -.001 | -.010 | .992 |
| **glossary_view** | .035 | .017 | .206 | 1.993 | .049 |
| **questionnaire_view** | .006 | .003 | .255 | 2.201 | .030 |
| resource_view | -.011 | .006 | -.296 | -1.812 | .073 |
| user_view | .004 | .018 | .032 | .225 | .822 |
| user_view_all | -.006 | .012 | -.062 | -.486 | .628 |

The regression analysis identified that the dependent variable was predicted by a combination of different independent variables. Although these results do not indicate a causal relationship, they do indicate that the students' system usage was related to higher scores on the final performance.

In specific, 3 variables mostly contributed to the correlation: spectrum of use and specifically moderate use, questionnaire and glossary inspection. Moderate use refers to the importance of system usage to student's performance. That indicates that students who used Moodle more intensively and more frequently also received higher grade. Questionnaire and glossary inspection were important due to the problem solving nature of the requested projects. The students had to carefully study the evaluation criteria and the definition of important concepts to better understand how to fulfill each given assignment. As a result, increased logged activity in the aforementioned modules found to be correlated with better student performance. This kind of findings stress the importance of providing a variety of complementary sources to the students, in order to enhance understanding, encourage individual explorations and increase sense of knowledge ownership.

## IV.    DISCUSSION

The results of this research contribute to understand, to some extent, which characteristics of an e-learning course are important for learning performance. They can be seen as a description of students' expressed behaviours and offer recommendations of how to design academic e-learning courses. The results could be beneficial both to designers of LMS as well as to educators aiming to introduce these systems in their course.

In this paper, an initial effort to explain the results presented above is being made. In order to better understand why specific variables seem to correlate with the students' performance, the initial numerical data describing the variables of system's use were compared. Although it was expected that the most critical usage variable is resource view (related to the recorded low level actions the users carried out in the entirety

of the course material throughout the semester), this assumption wasn't confirmed. This could be attributed to the fact that *all students* inspected the course material frequently, during the semester, at least while attending the compulsory laboratory session. Therefore, even in students with poor performance, a quite high value on the resource view variable is observed. As a result, the effect of resource view was not found significant. So, a crucial role in the models' construction plays the different usage of the system which seems to be understood in the sense of the different combination variables' usage.

Since the use of Moodle is an important factor affecting the performance of students, great attention should be given while designing academic courses with the use of LMS. Further investigation should be conducted in order to specify the reasons and the factors that affect students' expressed practices while interacting with a LMS, to facilitate system's usability and usefulness and to further encourage and motivate the learners to achieve deeper understanding.

## V.    CONCLUSIONS

In this paper, the impact of students' usage behavior while using Moodle in the context of a blended learning academic course was examined. From the regression model, it was derived that the recorded students' interaction practices were significantly correlated to the students' performance. *Moderate use* appeared as the most critical variable as a predictor in this study. According to the results obtained, it was also revealed that the usage variables that also explain students' performance are *Questionnaire view* and *glossary view*. Unexpectedly, the resource view was not significantly correlated to the student's performance. This could be attributed to the fact that all students' had to access the learning material in order to gain some initial understanding. It seems that deeper understanding was achieved through careful inspection of materials presented in the glossary and the questionnaire which contained the evaluation rubrics. However the issue requires further investigation, since the correlation trend is quite high and found to be significant at the 0.1 level.

It should be stressed that the multiple regression method applied does not imply causal relationships, but correlation between variables or sets of variables were described instead. In a first attempt to explain the findings of the reported cases study, it is considered that students' performance is correlated with specific aspects of system usage, as depicted in the collected log files. Questionnaire and glossary inspection emerged as significant variables positively correlated to the student's performance. However, the results are not subjects to generalization since the learning setting and the design of the course's material greatly affects the obtained interaction data.

The research presented in this study has several limitations. The sample includes exclusively students from a Department of Social and Humanities Studies with specific characteristics such as age, gender, computers skills and experience etc. Further investigation in different contexts and levels of

education is required for the generalization of results. In addition, findings from studies related to how learners form their goals, which strategies they follow [19], what criteria they use to evaluate information and how they adapt to any given learning environment [20], can update existing design and evaluation practices for LMS [21] and consequently differentiate to an extent the students' practices. In addition, the degree of contribution of each interaction's characteristics and perceptions to the students' learning outcome requires further examination. The aforementioned limitations constitute future research goals.

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