THE IMPACT OF MOODLE QUIZZES ON STUDENT PERFORMANCE: THE CASE OF A STATISTICS COURSE

Lan Umek, Damijana Keržič, Nina Tomaževič,
and Aleksander Aristovnik
University of Ljubljana
Slovenia

Abstract

In this paper, the influence of students' activity in an e-classroom in a blended learning environment on their final exam performance is considered. The data set includes 92 participants of the *Basic Statistics* course. In the e-classroom, students self-study certain topics and check their newly acquired knowledge with quizzes. A strong correlation between the scores achieved for the quizzes and final exam points was discovered. Moreover, significant differences in performance were found between students who had completed most of the quizzes and those who did not. Therefore, the quality of individual study in an e-classroom positively influences a student's performance.

Keywords: blended learning, Moodle, students' activities, quizzes, students' performance

Introduction

Higher education institutions all over the world are increasingly adopting blended learning, which combines face-to-face and technology-mediated instruction (Porter, Graham, Spring, & Welch, 2014) with the aim of complementing each other (Graham, Woodfield, & Harrison, 2013). The use of Learning Management Systems (LMSs) has grown exponentially in the last few years and come to strongly impact the teaching and learning process (Cerezo, Sánchez-Santillán, Paule-Ruiz, & Núñez, 2016; Romero, Espejo, Zafra, Romero, & Ventura, 2013). Moodle is one of the most popular open-source LMSs. It has a full range of functionalities that other similar programs have, including tools for posting and sharing course information, conducting online discussion, and administering online quizzes. Moodle is also an environment that facilitates 'social constructionist pedagogy' by providing avenues for students to collaboratively engage in learning and other academic activities (Zhang, 2008). All kinds of learner activities are crucial for an effective online teaching–learning process, and it is therefore necessary to search for empirical methods to better observe patterns in the online environment (Neuhauser, 2002).

Blended learning has been used for over a decade at the Faculty of Administration of the University of Ljubljana, Slovenia. E-classrooms there are provided in the LMS Moodle environment. In order to improve the satisfaction of key stakeholders, i.e., students, teachers and faculty management, regular analyses are performed every half-year by an internal team of researchers. These results give managers and teachers insights into the contemporary situation and give opportunities for improvements and further development.

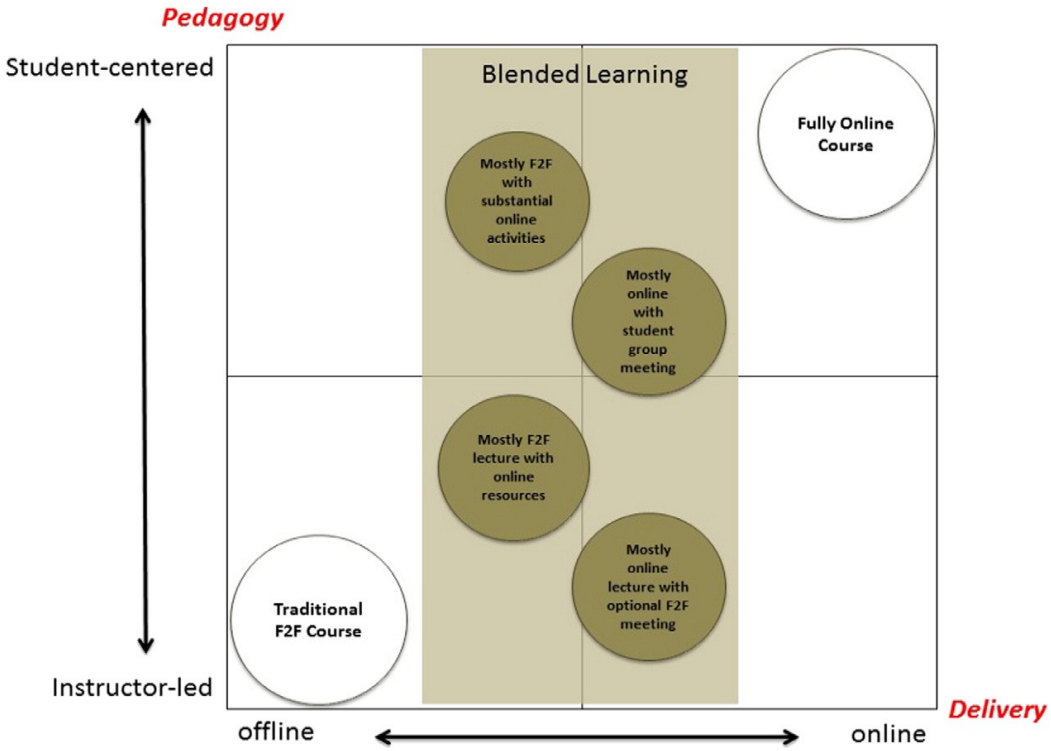
The purpose of our latest study was to examine the correlation between a student's active involvement in Moodle activities, specifically in quizzes, and the final exam results. The study's objective was to answer the following research question: "Is there any relationship between the total score achieved for the quizzes and the grade obtained at the final exam?" To provide an answer, we analysed data from the undergraduate course *Basic Statistics*. The paper is organized in the following way: we introduce the literature review, which is followed by the empirical study itself, including a description of the data, methodology and results. In the conclusion, we present the key findings, describe this study's main limitations and indicate possible avenues for further research.

Literature Review

When online higher education programs started to grow rapidly, they created a dynamic tension spawning ambivalence in certain sectors of higher education (Moskal, Dziuban, & Hartman, 2013), e.g., computer science (Romero, López, Luna, & Ventura, 2013), healthcare studies (Bergstrom & Lindh, 2018; Frantz, Bozalek, & Rowe, 2012), business studies (Ifinedo, Anwar, & Pyke, 2018), etc. A positive side effect of that tension included new learning environments that offered potential to maximize the effectiveness of contemporary teaching and learning. That movement had various labels such as mixed mode, hybrid, and combined, but blended learning has emerged as the dominant label for an educational platform that combines face-to-face and online learning (Moskal et al., 2013).

Evidence shows that the proportion of time devoted to online activities in a blended course is related to course performance (Romero, López, Luna, & Ventura, 2013). When using it in higher education courses, different proportions of the two types of learning are implemented, e.g., 50% face-to-face and 50% in the e-classroom, 70% face-to-face and 30% in the e-classroom, 60% face-to-face and 40% in the e-classroom (Chang, Dziuban, Hynes, & Olson, 1996).

While the definition of blended learning is clear and simple, its implementation is complex and quite challenging since virtually limitless designs are possible; depending on how much or how little online instruction is inherent in blended learning (Garrison & Kanuka, 2004). Diverse instructional models and best practices of blended learning have been reported from simple use of computer or online mediated technologies to full use of them for a complete course (Park, Yu, & Jo, 2016). Many combinations of learning, including blended learning, become possible when combining the type of pedagogical approach (instructor-led or student-centred) and the type of delivery (offline or online) – see Figure 1.



Source: Park, Yu, and Jo (2016).

Figure 1. Range of blended learning definitions.

The key stakeholders of the blended learning system are the institution's management, teachers, and students. Each tries to attain their particular goals. The management wishes to increase the efficiency of classroom resources and improve teaching by developing the members of staff. The teachers aim to adopt innovative, student-centred teaching practices. Students' goals are increased flexibility (in time and space) and expanded access, greater academic success and enhanced information literacy (Moskal et al., 2013).

According to Owston and York (2018), a consensus has emerged in the literature that students, on average, perform modestly better in blended courses compared to those in completely online or face-to-face courses across a broad range of subject areas and institutional offerings. However, learners often do not successfully adapt their behaviour to the demands of advanced learning environments, such as the LMS (Azevedo & Feyzi-Behnagh, 2011), because it requires greater independence and autonomy of the students for it is they who shall decide, for example, on what and how much to learn, how much time to invest, when to increase effort, etc. (Azevedo, Cromley, Winters, Moos, & Greene, 2005).

Whatever the motivation to blend, it is evident the strategy works best when clearly aligned with the institution's mission and goals while simultaneously addressing the needs of students, the faculty, and the institution (Dziuban, Hartman, Cavanagh, & Moskal, 2011). A clear vision and strong support are required when moving to a blended environment. It is only then that this modality cannot just succeed but become a transformational force for the university (Dziuban et al., 2011).

When preparing e-classrooms, there is a range of possible online activities in which students can engage and that motivate them to learn efficiently such as: announcements, links, lecture notes, resources, questions & answers, discussion forums, quiz items, group works, Wikis and assignment submissions (Park et al., 2016). Many studies have already investigated the impact of students' involvement in these activities, e.g., Cerezo et al. (2016) examined behaviour of students in a LMS and matched it to a different level of their achievement; Owston and York (2018) investigated the correlation between the time spent in an e-course and a student's performance. Romero, López, Luna, and Ventura (2013) investigated different data-mining approaches with a stress on the accuracy of predicting first-year computer science university students' final performance based on their participation in an online discussion forum. The forum may not only inform the students about their peers' doubts and problems, but can also inform instructors about their students' knowledge of the course contents via the thinking and opinions provided by students in forum posts.

The above issues became a challenge and basis for research. In our study, we focused on quizzes in an attempt to ascertain whether and how much the performance in solving the quizzes impacts students' performance at the final exams. The focus was not on the amount of time the students spent in an active role in the e-classrooms, but whether the effort to study new topics, as measured by the scores achieved for the quizzes, helped them gain more knowledge and thus better results in the final exams.

Data and Empirical Study

Blended learning at the Faculty of the Administration is being implemented in a ratio of 80–20, i.e., 20% of the content of each undergraduate course is provided in an e-classroom, both for the lectures (led by lecturer) and tutorials (led by assistant), including reading materials, assignments, quizzes, etc. Our data set consisted of 1st-year students of the professional study programme at the Faculty of Administration, University of Ljubljana, which is similar to the sample used in the study by Romero et al. (2013). Students enrolled in this program comprise the largest group of students at the Faculty. For our case study, we chose the *Basic Statistics* course*,* namely, one of the courses with the highest number of activities provided in the Moodle e-classroom. During a 15-week semester, the course includes 25 self-study topics covered neither in the face-to-face lectures nor the tutorials. Therefore, every week students must study one or two topics. The knowledge acquired of this additional content is then examined in two ways: (1) in the quiz that follows each topic addressed in the e-classrooms and (2) as part of the final written exam. A student has three attempts at each quiz and the best score is used as the final quiz outcome. All quizzes have the same maximum number of points a student can achieve, and the final score for the quizzes is calculated as the average of scores obtained for all 25 of them. To stimulate self-study, the result obtained by quizzes makes up 20% of the final grade of the subject, and a student obtains the remaining 80% at the final written exam at the end of the semester.

Methodology and Empirical Results

To investigate whether students' performance in quizzes relates to the knowledge they demonstrate at the final exam, we used data on 92 students who participated in final written exams. We scaled both final scores, namely at the exam and for the quizzes, between 0 and 100 points (i.e., percentage). The distributions of each variable in our data are shown as histograms in Figure 2.

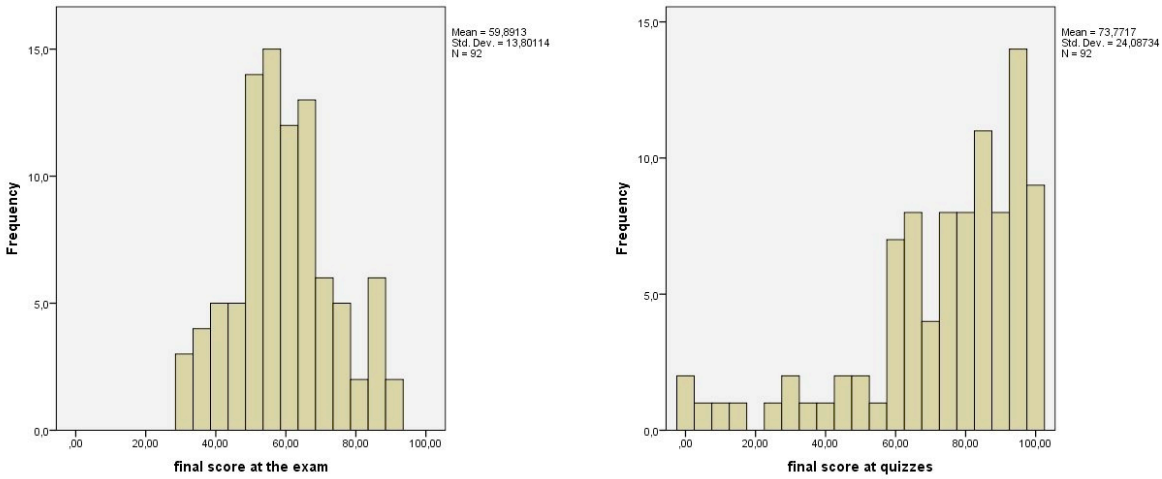


Figure 2. Distribution of scores at the final exam (left) and scores for quizzes (right).

Although the distribution of scores for the quizzes is more skewed to the left, both distributions do not deviate significantly from a normal distribution, namely *p* values according to a one-sample Kolmogorov-Smirnov test are 0.82 and 0.06, respectively. The mean score for the quizzes is higher (73.77) than that for the exam (59.89). The standard deviation is also higher for scores in the quizzes. Some students did not participate seriously in the quizzes – they simply took part at the start of the course – while others achieved maximum points for the quizzes as opposed to their exam scores, where maximum points were not achieved.

Altogether, 86% of the students achieved more than 50 points in quizzes. We computed a Pearson correlation coefficient between the final score for the quizzes and the final score at the exam. The correlation coefficient of 0.682 is highly significant (p = 7e–14), indicating a strong positive relationship between the score for the quizzes and for the exam. We can therefore conclude that a student who performed better in the quizzes on average had a better result for the final written exam.

Further, we investigated the relationship between scores in the quizzes and student's knowledge at the final exam in more detail. For this purpose, we divided the contents of the course into 11 topics (see Table 1). Questions and tasks in the final written exam were defined in terms of which topic they belong to. The topics in Table 1 are listed chronologically, which also corresponds to the order of basic topics to more complex ones. However, each topic is not covered by the same number of quizzes in the e-classroom

The case study participants were divided into two groups. The first group, named "Quizzes successful," consisted of 79 students (86%) who received at least 50% of points for each quiz. The second group of 13 students (14%) contains students with a worse performance in the quizzes (below 50%), named "Quizzes unsuccessful." Table 1 shows the mean score at the final exam for both student groups (measured in percentages) and the difference between the means. We computed *p* values (Sig.) using Student's t-test for independent samples.

Table 1

Mean Scores for all Topics Between Groups of Students (%), Difference Between Means and P Value

Topic	Quizzes successful	Quizzes unsuccessful	Difference	Sig.
1. Basic topics	69.62	59.23	10.39	0.13
2. Indices	60.91	58.41	2.5	0.78
3. Ranking, quantiles	45.67	24.15	21.52	0.02
4. Descriptive statistics (measures of Central tendency and variability)	59.29	45.5	18.94	0.02
5. Frequency distributions	81.74	67.31	13.79	0.01
6. Data collection	74.87	62.13	14.43	0.08
7. Probability	40.98	16.65	12.74	4.14E–03
8. Sampling	36.75	13.73	25.98	4.92E-04
9. Hypothesis testing	42.73	21.54	23.02	0.01
10. Correlation and regression	56.9	30.92	21.19	9.53E–07
11. Time series (forecasting)	68.01	49.07	24.33	1.95E–04

Table 1 shows the average performance in the group "Quizzes successful" was better for all 11 topics compared to the "Quizzes unsuccessful" group. With three exceptions (*Basic topics*, *Indices*, and *Data collection*), the difference in means is significantly greater than 0 (at the 5% level of significance). Two of the non-significant topics, *Basic topics* and *Indices*, are the first topics covered at the start of the course. These two topics cover basic principles of statistics where high school mathematics knowledge is enough for understanding. Therefore, the self-study of those two topics does not play a vital role in the results. The same principle applies to the topic *Data collection* which could be placed anywhere in the course since it is unrelated to any other topic and does not require in-depth knowledge.

The scores for the other eight topics indicate significant differences between the two groups of students. The largest differences can be found for the topics *Correlation and regression analysis*, where the difference of 21.19 points is highly significant, $p = 9.53E{-}7$, and *Time series* (forecasting), with a difference of 24.33 points, also highly significant, $p = 1.95E{-}4$. These two topics are the last two topics of the course, and both require knowledge of the

previous topics to better understand them. They are also the most advanced topics and are covered in two quizzes, namely, four quizzes in total.

Conclusion

At the institutional level, the biggest advantage of blended learning lies in its flexibility that allows institutions to tailor the concept when making improvements for a new generation of students. It extends learning far beyond the boundaries of the traditional classroom (Moskal et al., 2013).

The case study of the *Basic Statistics* course imparts a message to future generations of students at the Faculty. Namely, students' continuous self-study during the semester in the LMS inclined to taking part in the quizzes or any other activities can help increase their performance at the final exam. These findings also confirm the Faculty of Administration has made a wise decision concerning the use of blended learning, providing the basis for retaining the same framework for studying in the future. In the next academic year, we plan to add more activities to the course *Basic Statistics* – the data collected from the next generation of students will enable a comparison of two sets of students based on different amounts of activities in the e-classroom.

The presented research is a case study of a specific course at the Faculty of Administration. Therefore, the primary limitation of the methodology used is its generalisation, as noted in a similar case study (Romero et al., 2013). In the future, we will establish a framework for analysing several courses by investigating students' behaviour in different e-classrooms and linking that to their performance at the final exams.

References

Azevedo, R., Cromley, J. G., Winters, F. I., Moos, D. C., & Greene, J. A. (2005). Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia. *Instructional Science*, *33*(5-6), 381–412.

Azevedo, R. & Feyzi-Behnagh, R. (2011). Dysregulated learning with advanced learning technologies. *Journal of e-Learning and Knowledge Society*, *7*(2), 9–18.

Bergstrom, P., & Lindh, V. (2018). Developing the role of Swedish advanced practice nurse (APN) through a blended learning master's program: Consequences of knowledge organisation. *Nurse Education in Practice, 28,* 196-201.

Cerezo, R., Sánchez-Santillán, M., Paule-Ruiz, M. P., & Núñez, J. C. (2016). Students' LMS interaction patterns and their relationship with achievement: A case study in higher education. *Computers & Education*, *96*, 42–54.

Chang, L., Dziuban, C. D., Heynes, M. C., & Olson, A. H. (1996). Does a standard reflect minimal competency of examinees or judge competency? *Applied Measurement in Education*, *9*(2), 161-173.

Dziuban, C. D., Hartman, J. L., Cavanagh, T. B., & Moskal, P. D. (2011). Blended courses as drivers of institutional transformation. In A. Kitchenham (Ed.), *Blended learning across disciplines: Models for implementation. Hershey* (pp. 17–37). PA: IGI Global.

Frantz, J. Bozalek, V., & Rowe, M. (2012). The role of blended learning in the clinical education of healthcare students: A systematic review. *Medical Teacher, 34*(4), 216-221.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, *7*, 95–105.

Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. *The Internet and Higher Education*, *18*, 4–14.

Ifinedo, P., Anwar, A., & Pyke, J. (2018). Business undergraduates' perceived use outcomes of Moodle in a blended learning environment: The roles of usability factors and external support. *Telematics and Informatics, 35*(1), 93-102.

Moskal, P., Dziuban, C., & Hartman, J. (2013). Blended learning: A dangerous idea? *The Internet and Higher Education*, *18*, 15–23.

Neuhauser, C. (2002). Learning style and effectiveness of online and face-to-face instruction. *American Journal of Distance Education, 16*(2), 99–113.

Owston, R. & York, D. N. (2018). The nagging question when designing blended courses: Does the proportion of time devoted to online activities matter? *The Internet and Higher Education, 36*, 22–32.

Park, Y., Yu, J. H., & Jo, I-H. (2016). Clustering blended learning courses by online behaviour data: A case study in a Korean higher education institute. *The Internet and Higher Education, 29*, 1–11.

Porter, W. W., Graham, C. R., Spring, K. A., & Welch, K. R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers & Education, 75*, 185–195.

Romero, C., Espejo, P. G., Zafra, A., Romero, J. R., & Ventura, S. (2013). Web usage mining for predicting final marks of students that use Moodle courses. *Computer Applications in Engineering Education, 21*(1), 135–146.

Romero, C., López, M.-I., Luna, J.-M., & Ventura, S. (2013). Predicting students' final performance from participation in on-line discussion forums. *Computers & Education, 68*, 458–472.

Zhang, L. Z. (2008). MOODLE for integrative learning. In C. Bonk, M. Lee, & T. Reynolds (Eds.), *Proceedings of E-Learn 2008--World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (p. 2070). Las Vegas, Nevada, USA: Association for the Advancement of Computing in Education (AACE).

Author Details

Lan Umek
lan.umek@fu.uni-lj.si

Damijana Keržič
damijana.kerzic@fu.uni-lj.si

Nina Tomaževič
nina.tomazevic@fu.uni-lj.si

Aleksander Aristovnik
aleksander.aristovnik@fu.uni-lj.si