PREDICTORS OF STUDENT PERFORMANCE IN A BLENDED-LEARNING ENVIRONMENT: AN EMPIRICAL INVESTIGATION

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ABSTRACT

Modern technologies radically simplify the availability of the latest scientific literature and offer new possibilities for sharing knowledge. Yet, most higher education institutions still rely on traditional face-to-face teaching and use e-courses 'only' to supplement it. Such a combination of teaching methods is known as blended learning and is also used at the Faculty of Administration (FA), a member of the University of Ljubljana. The paper presents the results of a survey among FA students. The study's aim was to identify which aspects of blended learning increase students' knowledge level. Students evaluated 23 different aspects of blended learning on a 7-level scale. As a measure of the level of students' knowledge gained from each course, we used their final grades. Applying principal component analysis, we extracted six dimensions of blended learning which represented predictor components in a multiple linear regression with final grade as the dependent variable. Since courses at FA vary in many aspects, we performed the regression analysis for each obligatory course individually. Our analysis revealed for which courses the final grade can be reliably predicted from the aspects of blended learning. The study also showed that the aspects of traditional face-to-face learning are more strongly linked to better grades than the aspects of e-courses. However, for some courses certain characteristics of e-courses play a significant role in the final grade received.

KEYWORDS

Blended learning, Moodle, Higher Education, Student Satisfaction, Student Performance, Public Administration Programmes

1. INTRODUCTION

The Bologna Process required European universities to adapt their programmes as part of building the Higher European Education Area (EHEA) with aspects of harmonization, compatibility and comparability, such as two-cycle degree study (3 year: bachelor; 2 year: master), a comparable system of measuring student achievement (ECTS, competencies), student and teacher mobility, and the teaching–research relationship. Universities and their teachers were forced to make major changes to the pedagogical process concerning how to design the programmes, and the methods deployed to comply with the new requirements. A major novelty was the shift from a teacher-based learning style to the student-based approach whereby students become active participants in their own learning process, interact with the learning context and are committed to the learning process through which they acquire new responsibilities. Thus, the student-based style emphasizes the individual student and their interests, abilities, and learning styles. The teacher becomes a consultant of learning for individuals, helping and supporting students in achieving and building knowledge (Alducin-Ochoa & Vazquez-Martinez, 2016).

Technological developments, especially in the field of information and communication, have enabled many innovative approaches in educational environments by introducing technology to the pedagogical process and by enriching the learning experience. Education via the Internet using computers or mobile devices using new multimedia technology is nowadays known as e-learning. E-learning is unlike the prevailing forms of teaching in that it is unlimited by time or space. Learning management systems (LMSs) provide supportive services not only for effective and efficient learning, but also to manage, guidance and control the e-learning process. An LMS must not only be a system that supports the sending of messages, keeping an online gradebook or providing handouts and learning material, but should also allow one to be an

active participant in e-learning, both teachers and learners, e.g. by problem-solving teamwork, question and answer sessions or online simulations (Campanella et al. 2008; Kim & Lee, 2008).

Around the start of the new millennium, blended learning emerged as a new trend in teaching models and learning styles (Vo et al., 2017). Initially, blended learning was defined as 'the mixture of e-learning and classroom learning' (Masie, 2006) by the training field, as a promising alternative to e-learning because of the limitations in fostering 'interaction, context, and remediation' (Masie, 2006) of the latter. Subsequently, Graham (2006) elaborates blended learning as a combination of face-to-face instruction and computer-mediated instruction. Bernard et al. (2014) recommend that the proportion of blended course content delivered online range between 30 and 79 percent. The lower end of the range is sufficient to eliminate studies 'of incidental uses of Internet, such as downloading references and turning in assignments' (Means et al., 2013) and to differentiate blended learning from pure online learning (Allen & Seaman, 2009).

Graham (2006) posits that, as an interweaving of traditional face-to-face instruction and online learning, blended learning allows for more interactive and reflective knowledge construction. Multi-format resources, archived discussions, teachers' changing role as facilitators, and more time for discussion and reflection in this learning mode have been augmented by technologies (Mebane et al., 2008).

We are encountering the rise of e-learning in the higher education area. Allen and Seaman (2013) observed that e-learning courses in colleges and universities in the USA are showing greater growth in their number than traditional courses. In a survey conducted among European higher institutions, Gaebel et al. (2014) reported that almost all higher education institutions selected in the study had started to embrace e-learning, with most using blended learning (91%) and 82% offering online learning courses. They also found out that three-quarters of the institutions recognize that e-learning can change the approach to learning and teaching methods.

The recent boom in the blended learning industry has triggered an increase in the number of studies on blended learning. Considered as the 'new normal' mode of training (Norberg et al., 2011), the effect of blended learning on student performance has been researched in different contexts, e.g. in higher education, adult education, workplace training. There is a considerable volume of research on the benefits of satisfaction in higher education, especially linked to student performance (Martinez-Caro, 2011), retention (DeShields et al., 2005), class attendance or student engagement (Coates, 2005). Wu et al. (2012) observe that many e-learning studies conduct surveys to gauge learners' satisfaction with various items of blended learning, and a variety of methods is applied to assess the impact of these items on overall learning performance to provide a reference for improvements. Hung and Zhang (2012) point out that many researchers concentrate on evaluating the effectiveness of blended learning. Several models are available to measure student satisfaction, each with its own advantages and disadvantages (Chen, 2009).

In many studies, the results have shown blended learning has a positive impact on student performance (Larson & Sung, 2009; Lopez-Perez et al., 2011; Umek et al., 2015). On the other side, Brown and Liedholm (2002) compared three modes of instruction and discovered that face-to-face students did significantly better than online students and better than blended learning students for the most complex material. Results of a study by Kwak et al. (2014) strongly suggest that blended learning has no impact on student performance whatsoever. Moreover, student performance is not affected by the introduction of blended learning regardless of students' age, nationality, primary language or achievement level. But they found that introducing blended learning had a negative impact on male students but a positive one for female students.

The Faculty of Administration (FA) implemented blended learning in the 2010/11 academic year, using LMS Moodle. It was introduced progressively over three years, with some modifications, which have proved to be meaningful (for more, see Umek et al., 2015). Currently, 80% of every obligatory course is held in the traditional way while for the remaining 20% students gain knowledge from their activities in online courses. Each subject has its own e-course where an e-lecture is supported by e-content followed by a quiz in order to check understanding of the prepared content and the three extensive assignments intended for the tutorial are prepared during the semester. The teachers are obliged to give feedback on the correctness of the solutions in those assignments

In the study presented in this paper, we analysed 23 factors which we assumed influence students' perceptions of blended learning. They relate to the characteristics of an e-course (goals, materials, and assignments), lecturers' activities (assessments, responses), students' preferences regarding learning online or learning in the classroom, face-to-face learning and technical details about Moodle LMS (stability, administrative support). In the empirical study, we performed principal component analysis in order to extract components that describe dimensions of blended learning. We then used these components to predict

the students' grades. Since courses at the FA vary in many aspects (teachers, content, required computer skills, etc.), we analysed these impacts on each course separately. We believe the study presented below contributes some important findings to both theory and practice in the field of blended learning.

2. EMPIRICAL RESEARCH

2.1 Methodology and Data

In our study, we investigated the impact of different aspects of blended learning on students' performance. For this reason, we used a questionnaire based on our own recent survey (Aristovnik et al., 2016), where students' attitudes to e-learning were measured (Table 1, statements EC1–EC6, GI1–GI7), extended with three questions regarding face-to-face learning (Table 1, statements FF1–FF3) and seven questions on general attitudes to e-learning (Table 1, statements GE1–GE7), meaning that we examined a total of 23 aspects of blended learning. The students expressed their level of agreement with the statements on an ordinal scale from 1 ("totally disagree") to 7 ("totally agree").

Table 1. Aspects of Blended Learning

Abb.	Aspect of blended learning
GE1	Working with computers for study purposes suits me.
GE2	The Moodle e-learning system is easy to use.
GE3	The Moodle system is reliable and stable (it does not crash, submitted tasks are not lost).
GE4	I am satisfied with the support and assistance in the event of technical problems.
GE5	Working with computers for study purposes is not difficult for me.
GE6	E-learning contributes to higher student academic performance.
GE7	E-learning is a quality replacement for traditional learning in the classroom.
FF1	The content of the course interests me.
FF2	Course lectures are interesting for me and I like to attend them.
FF3	I find the face-to-face tutorial attractive and useful.
EC1	The virtual classroom of the course is organized transparently.
EC2	The goals (workload demands, grading) of this e-course were clearly stated at the start of the semester.
EC3	This e-course offers a variety of ways of assessing my learning (quizzes, written work, forums, files…).
EC4	I receive the teacher's comment/feedback on an assignment within less than 7 days.
EC5	I prefer fewer lectures in the traditional way (face-to-face) and more learning material processed in the e-course.
EC6	More course exercises could be carried out in the e-course instead of in the classroom.
GI1	The general impression of the e-course is good.
GI2	Study material and tasks of the e-course are presented in a clear and understandable way.
GI3	Finding certain activities in the e-course is simple.
GI4	The prepared learning material and tasks are consistent with the lectures in the classroom and supplement them.
GI5	The prepared material and assignments supplement the tutorial in the classroom.
GI6	Learning materials and activities in the e-course helped me to effectively study this subject matter.
GI7	The teacher gives me feedback/a response on my submissions (assignment, forum posts).

Source: Surveys, 2015 and 2016

The questionnaire-based survey was held in two consecutive academic years (2014/15 and 2015/16) and was carried out online. Students voluntarily participated in the survey, without any coercion or undue influence. We asked them to insert their student ID number to help us link the results obtained with their grades. We obtained the opinions of 639 students. They evaluated 46 undergraduate obligatory courses; on average, each student evaluated 5.2 e-courses. We collected 3,334 evaluations of e-courses. In addition, we collected the students' grades from our student information system – the exam database for all courses included in the survey.

In order to reduce the high dimensionality of our data set and make the results more comprehensive, we performed principal component analysis on the questionnaire data. We used the Kaiser criterion to determine the number of components. A varimax rotation was used to increase the interpretability of the extracted components. New variables (components) were determined as arithmetic means of the variables with high factor loadings (above 0.5). We evaluated the new components using Cronbach's alpha. Components with Cronbach's alpha above 0.7 were kept in our data set.

Completing the described transformation of the original datasets split the dataset (consisting of extracted components) into 46 subsets, each corresponding to an individual course. We added a student's final grade to each dataset as the dependent variable and, since participation in the survey among higher years of the study was poor, certain courses received very few evaluations. Therefore, we retained only 24 courses (subsets) that each had more than 50 evaluations for further analysis. For each course, we performed linear regression analysis with extracted components as independent variables and final grade as the dependent variable. In the paper, we report regression models with R^2 above 0.13 and present components with a significant influence on the final grade.

2.2 Empirical Results

Principal component analysis reduced our 23 aspects of blended learning to six components, which explain 67% of total variance (TVE). We computed Cronbach's alpha for each of them. Since components 4 and 5 resulted in a poor Cronbach alpha, we skipped them from further analysis and therefore provided no names for them. We named the four other components based on the meaning of the aspects with the highest loadings. The factor loadings, naming of the components with the % of total variance explained (TVE) and Cronbach's alpha (factor loadings above 0.5) are shown in Table 2.

Table 2. Component loadings for aspects of blended learning

	Component					
	1 aspect on e-course	2 technical aspect	3 aspect on F2F learning	4 /	5 /	6 teacher's feedback
% of TVE	24.8	10.8	9.8	8.9	7.0	5.7
Cronbach's alpha	0.914	0.721	0.838	0.325	0.405	0.741
GE1		0.512				
GE2		0.722				
GE3		0.788				
GE4		0.819				
GE5					0.76	
GE6		0.499				
GE7					0.736	
FF1			0.831			
FF2			0.808			
FF3			0.627			
EC1	0.797					
EC2	0.815					
EC3	0.769					
EC4	0.536					0.648
EC5				0.904		
EC6				0.916		

GI1	0.791			
GI2	0.763			
GI3		-0.524		
GI4	0.712			
GI5	0.713			
GI6	0.637			
GI7	0.572			0.62

Principal component analysis revealed four blended learning dimensions, namely aspects on e-course, technical properties and support, face-to-face (F2F) learning, and teachers' feedback. These four latent variables were later used in the regression analysis as predictors (independent variables). On the whole data set, we failed to detect any significant relationship between these four blended learning dimensions and the final grade. For this reason, we further investigated such relationships for individual courses. This approach has several advantages over a global analysis: it takes the courses' specific properties into account; the final grades within a course are more comparable than grades overall; and, most importantly – it provides a list of courses in which blended learning helps to achieve better grades.

The analysis was carried out on each individual course (with more than 50 students' evaluations) with the final grade as the dependent variable. Table 3 summarizes the results of the regression analysis for six courses where the linear regression model sufficiently explained the variability of the final grade, i.e. with R^2 above 0.13 (Cohen, 1992). In the table, we show unstandardized regression coefficients (B) with the corresponding significances (Sig.), R^2 and number of responses (n).

Due to personally identifiable information, we anonymized the course names as "course 1", "course 2" through to "course 6". Instead of providing each course's name, we reveal information about the chair to which the course belongs, the year of study and the study programme Courses at the FA are run by the teaching staff from three chairs (EPSM: Chair of Economics and Public Sector Management, ALA: Chair of the Administrative-Legal Area and OI: Chair of Organisation and Informatics). The undergraduate study lasts three years – there are two undergraduate study programmes (UN: university study programme, PS: professional study programme).

Table 3. Results of regression analysis on six courses. Regression coefficient is significant at the levels 0.1 - *, 0.05 - **, 0.01 - ***

course	1		2		3		4		5		6	
chair	EPSM		ALA		EPSM		EPSM		EPSM		EPSM	
year	1		1		2		1		1		2	
study programme	PS		PS		UN		PS		UN		UN	
R^2	0.18		0.16		0.15		0.14		0.14		0.13	
N	97		177		65		77		139		113	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
intercept	1.96	0.144	5.42	0.000 ***	5.89	0.000 ***	3.29	0.058	4.79	0.000 ***	5.49	0.000 ***
aspect on e-course	0.31	0.504	0.33	0.016 **	-0.36	0.306	0.94	0.054*	0.57	0.008 ***	-0.19	0.374
technical aspect and support	0.16	0.355	-0.05	0.674	-0.14	0.447	-0.03	0.856	-0.13	0.300	0.07	0.612
aspect on face-to-face learning	0.39	0.012 **	0.31	0.002 ***	0.59	0.004 ***	0.24	0.202	0.03	0.823	0.02	0.838
teacher's feedback	-0.04	0.900	-0.38	0.000 ***	0.02	0.921	-0.48	0.021 **	-0.02	0.908	0.28	0.006 ***

Table 3 reveals that almost all significant relationships between aspects of blended learning and the final grade are found in courses from the Chair of Economics and Public Sector Management, with one exception (course 2) from the Chair of the Administrative-Legal Area. It is interesting that none of the resulting courses belongs to the Chair of Organisation and Informatics where more computer-based skills are used in the teaching and learning process. Since we restricted our analysis to courses that received more than 50 evaluations, it is no surprise that we discovered relationships only for the courses in the first two years of study (due to the third-year students' unresponsiveness).

The aspect on e-course had a significant positive influence on the final grade in three courses (courses 2, 4, and 5) from both chairs, but only from the first year of study. The results therefore suggest that characteristics related to an e-course (organization, general impression etc.) are linked to the final grade only in the first year of study. We suspect that students in higher years of study become used to the Moodle environment and all their e-course obligations (quizzes, assignments, etc.). Therefore, the organization of an e-course in higher years of study plays a less important role than in the first year.

On the contrary, the technical aspect and administrative support do not have a significant impact on students' grade for any course. Since this component is the only one not related to a specific course, we computed the correlation between its values and the final grade with all courses together. Additional empirical findings revealed no significant correlation ($r=0.007$, $p=0.681$) for the entire data set. We can therefore conclude that the technical aspect and administrative support exert no influence on students' grades at the levels we analysed.

Face-to-face learning has a significant positive impact on three courses (courses with the highest R^2, i.e. courses 1, 2, and 3), from both chairs, years of study and study programme. The results suggest that the influence of this component is strongest especially for the course from the Chair of the Administrative-Legal Area. This is no surprise since courses from the ALA chair focus their teaching process on traditional classroom discussions. The regression coefficient of the aspect on face-to-face learning for course 2 is highly significant ($B=0.31$, $p=0.002$). This means that by increasing students' attitude to the content, the quality of lectures and tutorials by 1 point (on a 7-level scale), we would on average expect an increase in the final grade of 0.31 (on a scale of 1 to 10). For the other two courses (courses 1 and 3), the increase would even be higher – for course 3, we expect an increase in the average grade by more than 0.5.

The last component we analysed was the teacher's feedback. Although we discovered it had a significant impact on the final grade for three courses (courses 2, 4, and 6), the empirical findings are only promising for course 6. The regression coefficients of teacher's feedback are negative for courses 2 and 4 (-0.38 and -0.48, respectively). In the future, this surprising finding will be investigated in detail. The empirical findings suggest that students with higher grades expected richer and more useful feedback from the teacher whereas the feedback was more useful for students with lower grades.

3. CONCLUSION

At the Faculty of Administration, we are currently in the third year of measuring students' satisfaction with blended learning. Our previous studies (Aristovnik et al., 2016; Umek et al., 2015) revealed that the satisfaction level with e-courses in Moodle LMS is high. In the previous analyses, we also identified which factors influence students' perceptions of the usefulness of e-learning. The study presented in this paper represents an upgrade of our previous work. We investigated which aspects of blended learning increase students' performance. From previous experience, we deduced that there is no general rule and therefore performed an analysis for all obligatory undergraduate courses.

We employed principal component analysis to determine four dimensions of blended learning, namely aspects of e-course, technical aspect and administrative support, face-to-face learning, and teacher's feedback. We failed to detect an overall (global) significant relationship between aspects of blended learning and the final grade. Therefore, we looked for such a relationship within each individual course. We identified six courses where the students' final grade is significantly linked to components of blended learning. We found that e-course aspects play a significant role in the first year of study, while the face-to-face approach still has the strongest influence. We failed to link attitudes to the technical aspect and satisfaction with administrative support with final grades. The most surprising finding in our study was the identification of two courses where the teacher's feedback is significantly negatively linked to the students' final grade. We

suspect that the teachers of these two courses did not fulfil the expectations of students with better grades while students with lower grades were satisfied with their feedback.

Our study revealed in detail that connecting satisfaction with blended learning and students' performance is a challenging task. We believe that the identification of courses which reflect this relationship is an important achievement – both for the course teachers and managers of the Faculty. On the contrary, for the teachers of other courses our study suggests they should focus on other pedagogical aspects such as motivation for study, more interactive lectures and tutorials, and the use of recent technology as complementary technique in the traditional classroom. This focus will increase students' grades and therefore "produce" more competent graduates.

Our study has several limitations: we did not investigate the teachers' role and did not ask the teachers to express their opinions on blended learning. Another future challenge is to increase the participation rate of students in the 3rd year of study. They have much greater experience with various e-courses, overcame technical challenges in the first year and hold different expectations regarding the e-course quality. Differences among years of study suggest we should extend our questionnaire with other aspects. Some of the new aspects will be more suitable for the first year of study, while others will be more relevant for more experienced students.

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