STUDENTS ONLINE INTERACTION IN A BLENDED LEARNING ENVIRONMENT – A CASE STUDY OF THE FIRST EXPERIENCE IN USING AN LMS

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Abstract: The main objectives of the research presented in this paper are to explore online interactions and engagement of students who are using a Learning Management System (LMS) for the first time in their studies, and the impact of different types of students' online interactions on their learning outcomes. To answer our research questions, we have conducted a semester-long study with 88 undergraduate students enrolled in the Quality Engineering course taught in the blended learning mode. Our findings show that the students perceived interaction as a dominant aspect of the online part of the course (done using the Moodle LMS). Our findings also provide evidence that different types of interactions can influences different levels of learning outcomes. If the acquisition of factual knowledge is desired, then interaction with learning content is the most influential. However, if higher levels of learning outcomes are to be achieved, then more interactive online communication is needed. The need for interaction is rising with increasing levels of learning objectives (outcomes). Our findings also show that students' involvement in more challenging activities, in order to fulfil more demanding learning objectives (like application of knowledge or analysis, synthesis and evaluation) increase their need for student-teacher and student-student interaction.

1 INTRODUCTION

Many universities have integrated e-learning into their courses aiming to widen the opportunities for learning as well as to leverage the potential that novel technologies offer for advancing the learning process. Many authors reported successful usage of communication and collaboration tools offered by today's Learning Management Systems (LMSs) when applied in a blended learning environment (Kember, McNaught, Chong, Lam, & Cheng, 2010; Barnard, Lan, To, Paton, & Lai,. 2009; Moon, 2007; Ruiz, Mintzer, & Leipzig, 2006; Wiecha, Gramling, Joachim, & Vanderschmidt, 2003; Moran & Myringer, 1999). However, one should notice that the reported research studies come primarily from developed world countries, whereas few research efforts have been devoted to the online teaching and learning practices in those countries which are only now starting to adopt e-learning practices. Being teachers in such a country, our experience as well as experience of our colleagues show that transferring a part or all of teaching and learning into an e-environment tends to suffer from the same problems as face-to-face 'traditional' teaching – to be based on one-way information transmission (i.e., ex-cathedra lecturing).

In Eastern European countries teaching at higher education institutions was and still is predominantly based on traditional ex-cathedra lecturing and transmission-based teaching, rather than constructivist approaches that allow for the development of critical thinking skills. Girgin and Stevens (2005) defined transmission-based teaching as a method where the instructor acts as an authoritative source of expert knowledge and passes on a fixed body of information to be practiced alone and reproduced by students on demand. For many university teachers, particularly in developing countries, teaching methods incorporating students' active participation (e.g., working on case studies, class discussions, etc) represent new and innovative ways of teaching. Bollag's (1996) claimed that at Eastern European universities, "*students have little control over their studies and few chances for classroom discussion*". Mertova and Webseter's research (2009) revealed a need for a more systematic move towards a student-centered

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approach, as well as a need for contemporary approaches to teaching, learning, and assessment in higher education in the Central and Eastern European countries.

The result of our previous research (Mijatovic & Jednak, 2011), which included 433 undergraduate students in Serbia, showed that only 31.9% of examinees had experience with active participation in classes in secondary school. This finding suggests that passive learning is still dominant in Serbian secondary schools. The same research showed that students, who had more experience with active participation in secondary school, prefer active teaching methods, actively participate in a class, and are more likely to be in the group of higher achievers.

In such circumstances, fostering students' active participation and interaction can be a difficult task, and every mean that can help in advancing the learning process is more than welcomed. Even though the usage of LMSs has become a well established practice in developed countries, in developing countries, it represents a new and innovative practice, and reports of its educational effects are still scarce. Aiming to contribute to this research area, we have conducted a research (case) study where we explored online interactions and engagement of students who are using an LMS for the first time in their studies. Specifically, we were interested in examining the impact of different types of students' online interactions on their learning outcomes.

2 BACKGROUND

In the context of education, interactivity implies 'doing' as opposed to 'being' (present) (Downes, 2007); it assumes students' active participation in the learning process, rather than their passive consumption of the content provided by teachers (O'Connell, 2007). In other words, when considered from the educational perspective, interactivity can be equated with social and creative engagement, where engagement is defined as "*student-faculty interaction, peer-to-peer collaboration and active learning...*" (Chen et al, 2008). The notion of engagement defined in this way is fully consistent with the Moore's typology of interaction in distance education (Moore, 1989). Specifically, by focusing on learning events, Moore defined three types of interaction: a) student–content interaction, b) student–teacher interaction, and c) student–student interaction. Anderson & Garrison (1998) extended Moore's framework with a few additional types of interaction thus creating a model, named Interactivity Triangle, which became a widely accepted model of interactivity in learning settings (Garrison & Arbaugh, 2007). Specifically, Interactivity triangle has students, teachers and content at its vertices. Each vertex is related with the other two and with itself, so that, for example, teachers are in interaction with students and content, but they also interact among themselves.

Modern learning theories stress the importance of interactivity in learning and call for social and creative engagement of students. For example, the Conversation theory argues that learning is a continual conversation; with the external world and its artefacts; with oneself; and also with other learners and teachers (Pask, 1976). Likewise, according to the Siemens' Connectivism, the digital age relies on connected learning which occurs through interaction with various sources of knowledge and participation in communities of common interest, social networks, and group tasks (Siemens, 2005). Connectivism also stresses the importance of technology in the learning process and the connection of individuals with technology as well as with other individuals through technology.

Numerous studies have demonstrated the benefits of interaction in the learning process, especially, student-student and student-teacher interaction. For example, Ellis (2001) reported the following positive aspects of online interaction: 1) access to peer knowledge, 2) availability of other students to provide feedback, and 3) an opportunity to reflect on the exchanged messages. Likewise, Johnson & Johnson (1989) reported that learning tends to be the most effective when students are in the position to work collaboratively, express their thoughts, discuss and challenge the ideas of others, and work together towards a group solution to the given problem. It has also been found that interactions among students within a study group facilitate the development of critical thinking skills, skills of self-reflection and co-construction of knowledge and meaning (Brindley et al, 2009).

On the other side, researchers and practitioners alike have found that interaction is not something that can be easily established in a learning environment. This is primarily due to the inappropriate course design (Brindley et al, 2009) and/or the students' lack of collaboration skills, such as decision-making, consensus building, and dealing with conflict (Finegold & Cooke, 2006). For example, Mercer and Fisher (1997) wrote that among different kinds of group discussions

(disputational, commutative, and exploratory), exploratory discussions have the highest educational value. However, a group of students can fail in developing and sustaining an exploratory discussion (e.g., when continuous disputes lead to frequent breakdowns of communication). Though this is not typical for graduate students, it tends to be frequent in K-12 or undergraduate classrooms where students are more susceptible to competition or immature group behaviours (Yardi, 2006). Siemens (2002) reported on similar findings. In particular, he defined a continuum of four levels of student-student interaction: 1) communication ('talking', discussing); 2) collaboration (sharing ideas and working together in a loose environment); 3) cooperation (doing things together, but each individual with his/her own purpose); 4) community (striving for a common purpose). He found that in online learning settings, interaction often does not go beyond communication/collaboration and that community level could be possible only in graduate level programs with high learner-learner contact.

3 METHODS

3.1 Research Questions

The research work presented in the paper was driven by the following three main research questions (RQs):

RQ1: How do students perceive different forms of online interactions in a blended learning environment?

In the scope of this RQ, we were interested in the students' perceptions of different kinds of interactions they have experienced within the LMS. In particular, we aimed to explore the students' experience with the following kinds of online interactions:

1) Interaction with colleagues – did students recognize their online interactions with other fellow students as important and valuable?
2) Interaction with teachers – did students perceive their interactions with the teacher as an important and valuable experience?
3) Teacher's feedback – was the teacher's feedback perceived as important and valuable?
4) Interaction with learning content – did the students use LMS only as "course material storage"? In other words, did they primarily favour this kind of interaction?

RQ2: Whether and to what extent different types of interactions influence different levels of learning outcomes?

Relations between students' perceptions of different types of online interactions and different levels of students' learning achievements (i.e., learning outcomes) are definitely complex. In the context of this study we were primarily interested in exploring the association of four above stated types of interactions (interaction with colleagues, interaction with the teacher, teacher's feedback and interaction with content) and different types of learning outcomes, namely acquisition of factual knowledge, application of the acquired knowledge, and Analysis, Synthesis and Evaluation (ASE) of knowledge. These types of learning outcomes are based on the Bloom's Taxonomy (Bloom, 1994) which states that skills in the cognitive domain revolve around knowledge, comprehension, and critical thinking of a particular topic. For each type of learning outcomes, we considered three possible levels of students' achievement: high, moderate and low achievement.

To answer this research question we needed to explore individual influence of each type of interaction as well as their overall influence. Accordingly, we further decomposed RQ2 into the following two research questions:

RQ 2.1: *What associations (if any) exist between different types of interactions and different types of learning outcomes?*

RQ 2.2: *What is the overall effect (if any) of different types of interactions on learning outcomes?*

Figures 1 and 2 (http://jelenajovanovic.net/ESEeL2012/supplementary-material.html) present the variables relevant for addressing RQ2.1 and RQ2.2, respectively, as well as the considered relations between these variables.

RQ 3: What effects do students' interactions have on learning outcomes when observed with other influential factors in a blended learning environment?

To address this research question, besides different kinds of online interaction, we also considered the following factors: perceived difficulty of the course content, perceived course relevance, opinion about the course literature, students' acceptance of (i.e., confidence in) LMS and perceived usefulness of LMS. We wanted to explore if there is a correlation between the students' perception of different kinds of interactions on one hand, and students' learning outcomes on the other, when these additional factors are considered as well. In addition, we wanted to identify the factors that act

as the strongest differentiators among the groups of achievements (high, moderate and low) in the three considered types of learning outcomes. Figure 3 (http://jelenajovanovic.net/ESEeL2012/supplementary-material.html) shows the variables relevant for addressing RQ3 and the considered relations between these variables.

3.2. Study Design

To answer our research questions, we organized a semester-long study in the scope of the Quality Engineering course taught at the largest state university in Serbia. Data were collected from students' assignments and the questionnaire they filled in at the end of the semester. By assessing the students' assignments, we were able to collect the data about the students' learning achievements. The students' responses to the questionnaire provided us with information about their perceptions of different factors influencing their experience of the learning process.

3.3 Study Participants

The study participants were undergraduate students of the 4th year who were enrolled in a 14-week Quality Engineering course during the Winter semester 2011. There were 120 enrolled students in total. Aside from face to face classes, students had a chance to use Moodle LMS, on a voluntary basis, to download teaching material, work on different interactive tasks and task oriented quizzes, and participate in on-line discussions. After the semester and the final exams were finished, a questionnaire was offered to all 120 students, of which 98 (81.60%) responded. Ten questionnaires were considered invalid due to being incomplete. Thus, 88 (73.3%) of the questionnaires were taken for analysis.

3.4 Data Collection and Analysis

In order to collect the data required for addressing RQ1, i.e., data about the students' perceptions of different kinds of online interactions they experienced during the course, we applied Critical Incident (CI) technique. In particular, we followed the instructions given by Johnson and Gusatafsson (2000) for conducting this technique. CI technique typically involves an interview or a questionnaire in which participants are asked to provide list of things they like and dislike about the object of research. In our research, we asked students to provide a list of five things they liked and disliked about their experience with the LMS they used in the course. This method was chosen because we did not want to have any kind of influence on students' perception of online learning they experienced. By recalling and mentioning their experience, an examinee provides evidence of specific experience which is valuable and important for her or him. A case in which some examinee has had specific experience but she or he did not mention it, is possible. However, in our case that kind of experience was not important, valuable or worthy of note. After collecting and coding critical incidents, we analyzed occurrences of same or similar critical incidents. We were specially focused on experiences in which any type of interactions was mentioned.

To collect the data required for exploring RQ3, i.e., data about factors other than online interactions that influence students' learning achievements, we prepared a questionnaire and at the end of the semester, asked the students to fill it in. The questionnaire allowed us to gather the data about students' a) perception of the difficulty of the course content; b) perception of the course relevance; c) opinion about the course literature; d) acceptance of (confidence in) the LMS; and e) perception of usefulness of the used LMS. The entire questionnaire is given in the Appendix (http://jelenajovanovic.net/ESEeL2012/supplementary-material.html).

Information on students' achievements was based on their scores on the assignments which included home works and mid/term and final exams. The achievements are analyzed in three areas in accordance with the types of learning outcomes defined in the course curriculum:

1. Acquisition of factual knowledge: scores obtained for answering multiply choice questions or providing short answers based on previously learned materials (factual knowledge).
2. Application of the acquired knowledge: scores obtained for applying accurate method in a new situation and solving a quantitative task (calculus).
3. Analysis, synthesis and evaluation (ASE): scores obtained for the ability to: i) provide adequate discussion of the results using proper argumentation, ii) identify motives and causes, iii) give argumentation in order to evaluate or propose solutions, iv) discuss implications and limitations.

Based on their scores, for each type of learning outcome, the students were then divided into three

groups: higher achievers (scores above 80%), moderate achievers (scores between 60% and 80%) and low achievers (scores below 60%).

To perform data analysis required for answering RQ2.1 we used descriptive statistics and cross-tabulation with a Pearson's Chi-Square statistic test for each item. For measuring the relative strength of an association between two variables we used Pearson's Contingency Coefficient (C). First, we tested whether there is any statistically significant association and if so, we proceeded with measuring the strength of the association. According to Nargundkar (2004) and Crewson (2008), if the values of the Pearson's Contingency Coefficient (C) range between 0.5 and 1, there exists a strong or high association; values between 0.3 and 0.5 indicate a moderate association, and those between 0.1 and 0.3 show a low association.

In order to find out how different aspects of blended learning influence students' achievements and how strongly each one of them differentiates among the levels of achievements (questions RQ2.2 and RQ3), we conducted Discriminant Function Analysis (DFA) (Harlow, 2005) based on the Wilks' lambda statistic. The rationale for choosing this method is its adequacy for answering our research questions (RQ2.2 and RQ3) as well as its suitability for the type of data we collected.

For the purpose of applying DFA, we identified the following independent variables: X1 – Interaction with colleagues, X2 - Interaction with teachers, X3 – Teacher's feedback, X4 – Interaction with learning content, X5 - Perceived difficulty of the course content, X6 – Perceived course relevance, X7 – Opinion about course literature, X8 - Students' acceptance of (confidence in) LMS and X9 - Perceived usefulness of LMS. The first four variables were defined using the CI technique. After collecting and coding critical incidents, we analyzed occurrences of the same or similar experiences by following the propositions of the CI technique. For each study participant we observed if he/she has mentioned a particular experience (CI) and if so, was it defined as positive or negative. Based on that, the considered experience was characterized as negative, not mentioned, or positive. Accordingly, variables X1-X4 were assigned one of the following values: 1 – negative, 2 – no mentioning, or 3 – positive. Variables X5 – X9 are formed trough a summated scale defined in the questionnaire used in the study (see Appendix). Theory background for variables X8 - Students' acceptance of (i.e., confidence in) the used LMS and X9 - Perceived usefulness of the used LMS are taken from Technology acceptance model originally proposed by Davis (1989).

DFA is conducted separately for each of the three types of learning outcomes which are considered as dependant variables with three possible values (low achievers, moderate achievers and higher achievers). Interpretation of DFA is based on discriminant loading. According to Hair et al. (2009), discriminant loadings are less affected by multi co-linearity and thus more useful for an interpretative process. According to the same authors, discriminate loadings above ± 0.40 should be used to identify substantive discriminant (independent) variables. The canonical correlation coefficient (CC) is used to reflect the percentage of variance in the dependent variable explained by the mutual influence of independent variables. According to Harlow (2005), the substantial value of canonical correlation is 0.30 or higher, where the value of 0.30 corresponds to about 10% of the variance explained.

4 RESULTS AND DISCUSSION

In this section we present and discuss the study results from the perspective of our research questions (see Section 3.1).

4.1 RQ1: How do Students Perceive Different Forms of Online Interactions in a Blended Learning Environment?

Our results show that the main perceived positive aspects, among all the identified aspects of using an LMS in a blended learning environment are related to the students' engagement and interaction. The majority of the students (90.9%) mentioned at least one type of online interactions as either a positive or negative experience. More details are given in Table 1 where we presents the results we got by analyzing the students' "critical incidents".

As Table 1 indicates, majority of the students (84.1%) mentioned human interaction (e.g. interaction with colleagues and teacher, interaction with colleagues and interaction with the teacher) as a positive experience. In other words, human interaction is seen as the dominant positive aspect of students' experience of the online part of the course. Some students mentioned more than one experience (CI) related to interaction (e.g., interaction with colleagues and teacher, interaction with colleagues and interaction with teacher). However, we found

Table 1: Students' experiences related to different types of interactions.

Type of interaction	Critical incidents					
	Positive		No mentioning		Negative	
	number	%	number	%	number	%
Interaction	74	**84.1**	14	15.9	0	0
Interaction with colleagues and teacher	24	27.3	64	72.7	0	0
Interaction with colleagues	36	40.9	52	59.1	0	0
Interaction with teacher	38	43.2	50	56.8	0	0
Teacher's feedback	40	**45.5**	39	44.3	9	**10.2**
Feedback time	29	33.0	50	56.8	9	10.2
Feedback related to achievements	23	26.1	65	73.9	0	0
Feedback accuracy	3	3.4	85	96.6	0	0
Interaction with learning content	52	**59.1**	36	40.9	0	0

detached groups of cases in which interaction with colleagues and interaction with the teacher are mentioned separately (48% and 52%, respectively, of all who mentioned human interaction). Even though, in 27.3% of these cases we observed critical incidents related to "interaction with colleagues and the teacher" present together with separate interactions (i.e., only with colleagues, or only with the teacher), we will use separate interactions (interaction with colleagues and interaction with the teacher) as variables in further analysis.

Even though interaction with colleagues in an LMS was recognized as a positive, important and valuable experience by 40.9% of all the participants, none of them mentioned only this (among all observed) type of interaction. Explaining the positive aspects of interaction with colleagues, students wrote: "*I like the chance to work with colleagues I even do not know well*" or "*It is interesting to discus with colleagues about task problems related to course*".

While 43.2% of the students perceived their online interactions with the teacher as an important and valuable experience, only in three cases (3.4%) this was the only type of observed interaction. Explaining the positive aspects of this type of interaction some students wrote: "*It's great to have a chance to argue with teacher*" or "*discussion with teacher is available whenever I need her*".

Teacher's feedback was perceived as important, valuable and mostly positive experience in 55.7% of cases, but only 3 students (3.4%) mentioned only this (among all observed) type of interaction. Closer look on "critical incidents" in this area suggests that the students saw the teacher as a dominant source of desired feedback. We did not find any report on the experience with colleagues' feedback. "*Fast reaction and responding on inquiry*", "*fast clarification of confusions*", "*late answering*" or "*I had a chance to get right answers*" are critical incidents of ours examinees related to the teacher's feedback. All critical incidents observed in this area can be sorted in three groups: timely feedback, feedback on student's achievements and feedback accuracy (right answers).

However, one-way information transmission proved as still very important. The results indicate that students' experience with the other course's web site, where (two-way) interaction was not possible, shaped students' experience with new learning environment. Interaction with learning content is mentioned in 59.1% of cases, but 11 (12.5%) students mentioned only this (among all observed) type of interaction. Critical incidents in this category were: "*all course materials are on one place, I can reach it any time I want*", "*all information could be found on one place*" or "*I can download what I need*".

4.2 RQ 2.1: What Associations (if any) exist between Different Types of Interactions and Levels of Learning Outcome?

Table 2 presents the results we obtained by analyzing associations between different types of interactions and different types of learning outcome. A statistically significant, strong and positive association is found between interaction with learning content and the acquisition of factual knowledge. Furthermore, a statistically significant, positive but moderate association is found between: interaction with colleagues and the acquisition of factual knowledge; teacher's feedback and Analysis, synthesis and evaluation (ASE) of knowledge. Finally, a statistically significant, positive but low association is found between: interaction with colleagues and ASE; teacher's feedback and application of knowledge. We did not find any evidence that the experience of interaction with the teacher had statistically significant influence on the students' achievements.

These results suggest that if acquiring factual

Table 2: Crosstabs' statistics and measures of association between different types of interactions and types of learning outcomes (N=88).

Types of interactions		Factual knowledge df = 2	Application df = 2	Analysis, Synthesis and Evaluation (ASE) df = 2
Interaction with colleagues	Chi - Square	12.633**	5.423	6.222*
	C	0.379**		0.266*
Interaction with teacher	Chi - Square	0.955	5.903	3.953
	C			
Teacher's feedback	Chi - Square	1.956	6.588*	11.255**
	C		0.274	0.358**
Interaction with learning content	Chi - Square	26.488**	1.031	5.455
	C	0.548**		

* significant for $p < 0.05$; ** significant for $p < 0.01$;
C - Pearson's Contingency Coefficient (0.5 - 1 strong or high; 0.3 - 0.5 moderate and 0.1-0.3 low association)

knowledge is desired, then students' focus is expected to be on interaction with the learning content. On the other side, if higher levels of learning outcomes are wanted, then two-way interaction, i.e., communication and collaboration are needed. Finally, the results related to interaction with teacher and teacher's feedback suggest that teacher is seen as an authoritative source of expert knowledge; students are not used to or not encouraged enough to discuss with teacher as equal.

4.3 RQ 2.2: What is the overall Effect (if any) of Different Types of Interactions on Learning Outcomes?

Even though the majority of our examinees reported reliance on multiple types of interaction (Section 4.1), we did not find strong and statistically significant association between different types of interactions. Multi co-linearity in DFA is identified by examining tolerance values. The tolerance values for all of the independent variables were larger than 0.10, so the level of multi-collinearity was acceptable in this analysis (Hair, 2009).

With respect to the acquisition of factual knowledge (the first two rows of Table 3), values of squared canonical correlations suggested that mutual influence of the observed types of interactions is positive, and corresponded to 36 % of the variation between the group of higher achiever and the group comprising moderate and lower achiever. The second discriminant function suggests that mutual influence of all types of interactions could explain about 13% of difference between moderate and lower achiever. The discriminant loadings of independent variables that highly contribute, among other variables, to the assumption that the students will be in the group of higher or moderate and lower achievers are bolded in Table 3. For the acquisition of factual knowledge, interactions with learning content (X4) have dominant effects on variations between higher and moderate and lower achievers, whereas interaction with colleagues (X1) has dominant effect on variation between moderate and lower achievers.

When the application of knowledge is considered, mutual influence of the observed types of interactions is positive and corresponds to 24 % of the variation between the group of higher achievers and the group of moderate and lower achievers (Table 3, rows 3 and 4). The second discriminant function failed statistical significance. Dominant discrimination ability in this area has teacher's feedback (X3).

When higher ASE skills are considered, the observed types of interactions can explain 12% of the variation between the group of higher achievers and the group consisting of moderate and lower achievers, and 9% of the variation between groups of moderate and lower achievers (Table 3, last two rows). In this area, interactions with colleagues (X1) and the teacher (X2) have dominant effects on variations between higher and moderate and lower achievers, but teacher's feedback (X3) has dominant effect on the variation between moderate and lower achievers.

4.4 RQ 3: What Effects do Students' interactions have on Learning outcomes When Observed with other Influential Factors in a Blended Learning Environment?

The tolerance values for all the independent variables were larger than 0.10, thus indicating that the level of multicollinearity was acceptable in this analysis (Hair, 2009). In area of acquiring factual knowledge, all observed independent variables

Table 3: Summary statistics for discriminant function analysis.

Dependent variable - learning outcomes	Discriminant Loadings (Structure correlations) X1	X2	X3	X4	Canonical correlation
Factual knowledge; Λ = 0.553 (p = 0.000) (separate higher achiever from moderate and lower)	0.410	0.137	0.037	**0.846**	0.604
Factual knowledge; Λ = 0.870 (p = 0.009) (separate moderate from lower)	**0.689**	-0.038	0.384	-.356	0.360
Application; Λ =0.738 (p = 0.001) (separate higher achiever from moderate and lower)	-0.458	-0.384	**0.669**	0.193	0.488
Application; Λ =0.969 (p = *0.454)* (separate moderate from lower)	*-0.062*	*0.900*	*0.450*	*0.075*	*0.176*
Analysis, Synthesis and Evaluation (ASE); Λ = 0.793 (p = 0.012) (separate higher achiever from moderate and lower)	**0.656**	**0.504**	0.210	0.078	0.357
Analysis, Synthesis and Evaluation (ASE); Λ = 0.906 (p = 0.042) (separate moderate from lower)	-0.357	0.309	**0.849**	-0.161	0.306

X1 - Interaction with colleagues
X2 - Interaction with teacher
X3 - Teacher's interaction
X4 - Interaction with learning content

Table 4: Summary statistics for discriminant function analysis.

Dependent variable	Discriminant Loadings (Structure correlations) X1	X2	X3	X4	X5	X6	X7	X8	X9	Canonical correlation
Factual knowledge; Λ = 0.356 (p = 0.000) (separate higher achiever from moderate and lower)	.295	.092	.037	**.551**	.345	.100	-.272	-.269	-.033	.750
Factual knowledge; Λ = 0.814 (p = 0.034) (separate moderate from lower)	**.492**	.009	.303	**.417**	-.157	.297	-.093	.220	.142	.431
Application; Λ =0.415 (p = 0.001) (separate higher achiever from moderate and lower)	.154	-.063	.297	-.075	**.690**	-.042	-.018	-.317	-.098	.623
Application; Λ =0.679 (p = 0.000) (separate moderate from lower)	.327	.383	**.438**	.133	.157	-.072	**.682**	-.022	.255	.567
Analysis, Synthesis and Evaluation; Λ = 0.388 (p = 0.000) (separate higher achiever from moderate and lower)	**.536**	.248	.281	.227	**.580**	.234	-.047	.288	-.027	.648
Analysis, Synthesis and Evaluation; Λ = 0.669 (p = 0.000) (separate moderate from lower)	.356	.072	.220	.334	.232	.368	-.182	**.634**	.063	.575

X1 - Interaction with colleagues
X2 - Interaction with teacher
X3 - Teacher's feedback
X4 - Interaction with learning content
X5 - Perceived course content difficulty
X6 - Perceived course relevance
X7 - Attitude toward course literature
X8 - User acceptance (confidence) of LMS
X9 - Usefulness of LMS
DV - Dependent variable, Λ - Wilks' Lambda

contribute 56% of the variations between higher and moderate and lower achievers, and 19% of variations between moderate and lower achievers (Table 4, the first two rows). For this type of learning outcome, interaction with learning content (X4) has dominant effect on variations between higher and moderate and lower achievers. The variation between moderate and lower achievers is primarily determined by the interaction with colleagues (X1) and interaction with learning content (X4).

In area of application of knowledge, all observed independent variables contribute to 40% of the variations between higher and moderate and lower achievers, and 32% of variations between moderate and lower achievers (Table 4, rows 3 and 4). For this type of learning outcome, the perceived course content difficulty (X5) has dominant effect on the variation between higher and moderate and lower achievers, whereas teacher's feedback (X3) has dominant effect on the variation between moderate and lower achievers.

In area of Analysis, Synthesis and Evaluation of knowledge, all observed independent variables contribute to 42% of the variations between higher and moderate and lower achievers, and 33% of variations between moderate and lower achievers (Table 4, last two rows). In this area, the perceived course content difficulty (X5) and interaction with colleagues (X1) have dominant effects on variations between higher and moderate and lower achievers, whereas User acceptance of LMS (X9) has dominant effect on variation between moderate and lower achievers.

When observed with others influential factors, interactions still play an important role in achieving higher scores for all types of learning outcomes. The same results can be seen in this analysis as it was in previous: interaction with

learning content is more important in acquiring factual knowledge, while teacher's feedback and interaction with colleagues are needed for application and analysis, synthesis and evaluation of knowledge.

5 CONCLUSIONS

The main objective of the study reported in this paper was to explore online interactions and engagement of students who are using an LMS for the first time in their studies, as well as the impact of different types of students' online interactions on their learning outcomes. Our findings show that students perceive interaction as the dominant feature of learning supported by an LMS. Majority of the students (90.9%) mentioned at least one type of online interaction as a relevant experience when studying with the support of an LMS.

Even though students clearly articulated the difference between interaction with colleagues, teachers and learning content (the types of interaction defined in the works of Moore, 1989 and Anderson & Garrison, 1998) some specific differences can be observed. While the keywords related to interaction with colleagues are "discussions" and "opinion and experience exchange", when reflecting on their communication with the teacher, students more often used words like "response" and "answering questions". These results suggest that teacher is seen as an authoritative source of expert knowledge. One of the consequences of ex-cathedra lecturing and transmission-based teaching is that students are not used to and often not encouraged enough to discuss with teacher as equal. This conclusion is further supported by the fact that the students did not recognize colleagues' feedback as worthy of note. In a broad sense our findings are compliant with those of Siemens (2002) – we have provided an evidence of the existence of only first two levels of interaction with colleagues: communication (talking or discussing) and collaboration (sharing ideas and working together in a loose environment).

Furthermore, our findings provide evidence that

different types of interactions can influence different levels of learning outcomes. If the acquisition of factual knowledge is desired, then interaction with learning content is the most influential. On the other side, if higher levels of learning outcomes are to be achieved, then communication (i.e., two-way interaction) is needed. In a nutshell, the need for interaction is increasing with the increasing level of desired learning objectives (outcomes). Additionally, our findings show that students' involvement in more challenging activities, in order to reach more demanding learning objectives (like application of knowledge or analysis, synthesis and evaluation) increase their need for student-teacher and student-student interaction.

The presented research and generalization of data display some limitations due to the small sample and only one course considered. In addition, the limitation is in the fact that we observed the presence of different types of interactions, but not their quality. Also, the examinees in our research are taken as a relatively homogenous group and the impact of the specific needs and motives were not taken into account.

In order to further verify our findings and make them more widely applicable, in our future work we intend to organize another study with more students enrolled in different courses. We also plan to make use of the Practical Inquiry framework (Garrison et al, 2001) to analyze the messages that students exchange in online communication channels in order to assess the quality of their interaction. Additionally, we intend to examine other potentially influential factors on students' achievements such as different teaching strategies and students' motivation.

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