Analysis of Learning Outcomes in Gamified Blended E-learning Course

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Learning outcomes describe what students will learn in a certain period of time after the end of the teaching activity and therefore they need to be verified. Higher education distinguishes several types of learning outcomes such as general, study program, course and course topic. This paper analyses learning outcomes of the course topic in the gamified course, Web Design and Programming (WebDiP). Midterm exams were chosen for the analysis. Each question of the midterm exam is assigned to the corresponding learning outcome of the course topic which is verified with them. Also, each learning outcome is further classified into levels using Bloom's taxonomy. The research goal is to discover the reason why and which learning outcomes are more difficult to achieve. Furthermore, is there any correlation between levels of learning outcomes, the number of points in each midterm exam, points from the project and the total number of points achieved in the course. In accordance with the obtained results, proposals for improving the course for the next academic year are presented.

Keywords: learning outcomes, gamification, higher education, LMS, bloom taxonomy, analysis

INTRODUCTION

Learning outcomes are defined as "statements that describe what a student needs to know, understand and be able to do after successfully completing the learning process" (Divjak, 2009, p.4). In Republic of Croatia systems of scientific activity and higher education are regulated with the science and higher education law (NN 123/03) and subsequent amendments to this law: 198/03, 105/04, 174/04, 02/07, 46/07, 45/09, 63/11, 94/13, 139/13, 101/14, 60/15, 131/17 ("Law on Scientific Activity and Higher Education"). According to paragraph 2 of act 78 the law stipulates that the study program must have a specific purpose, mission and vision with a defined general learning outcome. Dublin descriptors can serve as a good example for the formation of the general learning outcomes. Learning outcomes can also be classified into specific learning outcomes such as study program, course, and course topic (Kermek, 2009, p.29).

Erjavec (2009, p.66) mentions that various taxonomies are used to define learning outcomes, educational goals, their application in the study program and evaluation of knowledge. One of the most famous is Bloom's taxonomy. Bloom's taxonomy includes six categories of cognitive skills. Those categories are knowledge, comprehension, application, analysis, synthesis, and evaluation. When defining learning outcomes, one rule should be followed. More precisely, one verb for one learning outcome of the process. The most common critique is that Bloom's taxonomy shows too simplistically the nature of human

thought and its connection with learning. The reason for this is because it uses only the concept of difficulty (complexity) as the feature that separates cognitive process levels.

Zlatović (2011, p.100-116) states that critics of Bloom's taxonomy have been tried to correct whit the revised Bloom's taxonomy and the new taxonomy of educational objectives. The revised Bloom's taxonomy contains two basic dimensions. Respectively there are the knowledge dimension and the cognitive dimension. The knowledge dimension is a novelty in relation to Bloom's taxonomy. On the contrary levels of cognitive dimension are like those of the original Bloom's taxonomy. The new taxonomy of educational objectives is similar to the revised Bloom's taxonomy. Meaning that it is a two-dimensional taxonomy within which educational goals can be classified according to the level of the mental process (1st dimension) which acts on the target domain of knowledge (2nd dimension). Therefore, any attempt to form a taxonomy based on the complexity of mental processing is doomed to failure. Once the educational goals are defined, they need to be verified. Important aspects related to verification are the used LMS of the organization and the compliance of the verification process with the teaching materials. The most common methods of verification in practice are questions with multiple offered answers. In the context of the new taxonomy, questions with multiple offered answers are suitable for verifying a very small range of educational objectives (recognition of information within all domains of knowledge). While the largest range of educational objectives (all higher-level objectives and majority lower-level objectives) can be effectively verified using an essay test. Except in writing, it can also be verified orally.

This study examines the effects of learning outcomes at the topic level in the course "Web Design and Programming". Further in the paper we use the acronym "WebDiP". The course is held at the 3rd year of university undergraduate study, study program Information Systems, at the Faculty of Organization and Informatics (FOI), University of Zagreb. FOI uses the LMS system Moodle. Goal of the course is to introduce students to the elements of web technologies, designing and creating web pages, and developing web applications ("Web Design and Programming [WebDiP]"). The course is gamified from the Academic year (AY) 2015/2016.

Kermek et al. (2016) describe the structure of the course in the 1st year of applying gamification. Also, how the course was prepared for gamification and what are the gamification results between the test and experimental group. Every year, the course and gamification functionalities are improved based on a survey that students complete at the end of the semester. From the AY 2016/2017, all students were included in the gamified course.

After two years Kermek et al. (2018) presented their results of applying gamified elements to the course over several AY. This research continues the previous research, but with a focus on the learning outcomes of the course topics using data from the AY 2018/2019. Table 1 shows elements of the scoring system and their ratio in overall points for the course WebDiP in the AY 2018/2019. Selected elements to verify the learning outcomes at the topic level are midterm exams. The Midterm exams are chosen because they are written in controlled conditions, which reduces the probability to use illicit means.

TABLE 1
ELEMENTS OF SCORING SYSTEM

Elements	Points
Attendance (lectures, seminar, labs)	5.0
Homework (1-4)	25.0
Seminar	6.0
Midterm exam 1	7.0
Midterm exam 2	8.0
Lecture activity	2.0
Lab's activity	2.0
Project	45.0
Total	100.0

RELATED WORK

Wangpipatwong and Papasratorn (2007) investigate through a case study how the constructivist e-learning system (CES) affects student learning outcomes. Their aim was to compare the learning outcomes and knowledge progress of students using CES in relation to the constructivist e-learning environment (CEE). CEE is composed of three constructs. There are research, collaboration, and construction. T-test was used to analyse learning outcomes. Results have shown that more learning outcomes and knowledge were achieved in the case study when the CES system was used.

Ho and Kuo (2010) state that a number of studies exist that focus on the effectiveness and benefits of e-learning. Their work investigates the characteristics of learning outcomes of IT professionals. Specifically, what is the relationship between one's own learning style and learning outcomes. Data from 50 technology companies located on a science campus in Taiwan was collected. The sample was N=239. Data was analysed using structural equation modeling. The results show that the effect of personal computer attitude amplifies the learning outcome and is related to previous experience of using the LMS systems.

Eom (2011) explores through path analysis the interrelationship of the LMS systems, self-efficacy, and the student's perception of course learning outcomes in higher education. Results showed on a sample of N=674 that the quality of the LMS, the quality of information, computer self-efficiency, use of the system, self-regulated learning and student satisfaction affect the achievement of learning outcomes.

According to Alhazmi and Rahman (2012) Internet technologies are integrated into education systems around the world. They state that the most well-known LMS and CMS systems are Blackboard and Moodle. Most criticisms in the LMS relate to insufficient use of available features and the low student engagement in the system. This is partly caused to the inflexible course structure and the dependence of the teacher-centered approach that limits the student's role. For the effective use of technology and the improvement of learning theoretical, pedagogical and other related elements of e-learning should be considered.

Jang et al. (2015) mention that gamification of Internet learning content has been the subject of interest for the past few years. In their research, they determine the impact of gamification on learning and the moderating role of teachers. The results show that the elements of gamification contribute to learning outcomes. This is influenced by the student's acceptability and motivation, as well as prior knowledge tests. The gamified system is an effective medium for improving the effectiveness of the e-learning environment.

Yassine et al. (2016) mention that assessment of course learning outcomes is a fundamental measure of student success in a course. Learning analytics (LA) is a powerful tool for gathering information from students, teachers, and educational institutions about student progress and the learning process. Many useful LA tools are available on various LMSs such as Moodle, which records student activities. But there is a need for an integrated LA tool that can assess learning outcomes in courses and predict success and achievement in relation to activities. The paper proposes a framework for the development of LA in LMS Moodle. The framework measures learning outcomes through a built-in examination tool for each outcome and related LMS activity. Then the results are analysed to assess achievement of learning outcomes and propose improvements for the next semester.

Waheed et al. (2016) investigate the internal and external features of the LMS Moodle. Then how they motivate students to use the system and what subsequently affects their learning efficiency and academic success. The sample was N=276. Motivation theory, self-determination theory and cognitive theory are used to create the framework. Quantitative empirical research was conducted to test and confirm the hypotheses and research questions. Responses were analysed using Analysis of Moment Structures (AMOS) tool. It's been concluded that the internal and external module of the system affects student's perception, learning efficiency resulting in improved academic success.

According to Sáiz Manzanares et al. (2017) LMS offers a lot of information that is not suitable for all learning patterns. LA techniques enable the analysis of records of student and teacher activities. Learning patterns vary depending on the type of blended learning. The research analyses if there are significant differences between learning, learning outcomes and their learning patterns in the system. Also, whether there is a relationship between metacognitive and motivational strategy, their learning outcomes and learning patterns in the system. Moodle is used on a sample of N=129 students. The results revealed that

learning patterns can predict student learning outcomes. There is also a relationship between learning patterns and metacognitive strategy.

Nguyen et al. (2018) conclude that one of the difficulties students face is the lack of regular supervision as well as the need for additional guidance to effectively support the learning process. The paper proposes a model of forecasting learning outcomes based on the interaction of the student and the LMS through the dashboard, applying LA. This approach is based on machine learning and data mining techniques. It explores whether it is possible to accurately predict student learning outcomes based on their interaction and how to track and guide students for more effective e-learning. The results show that more than a third of students have results close to the predicted results with an accuracy of over 50%. Although a small sample was used, there was a need to use LA in predicting students learning outcomes through their learning activities.

Kolekar et al. (2018) emphasize that education is a process that facilitates learning or acquiring skills, knowledge, values, beliefs, and habits. With the development of technology, teachers and students are increasingly going towards e-learning applications. E-learning applications are generally open source and by modifying these applications as needed, educational institutions can modify them to their needs. The paper presents an approach to identifying learning styles based on the Felder-Silverman learning style model (FSLSM). FSLSM enables accurate quantitative assessment of student preferences on a scale along four dimensions. There are active or reflective, sensing or intuitive, visual or verbal, and sequential or global. Moodle logs data is used. Students are grouped by categories as in the FSLSM model. For each of the identified learning styles (group of students) an adaptive interface is generated according to FSLSM. The results are confirmed using statistics.

Olstad and Rouhani (2019) emphasize how the Bologna process has started a series of reforms. One of the reforms is the development of learning outcomes through ECTS points. Which means that universities, must define and describe learning outcomes for their programs, studies, and courses. So that students know what they will achieve upon successful completion. The paper provides guidelines that can facilitate the writing of learning outcomes for a course about programming. There is no exact way to write learning outcomes, but the use of taxonomies in defining them is recommended.

METHODOLOGY

This research deals with verifying course topic learning outcomes of the course WebDiP using student data from the academic year 2018/2019. Most of the course activity's students complete at home or outside controlled conditions. Therefore, midterm exams were chosen to verify the learning outcomes. WebDiP is a project-based course which applies the so-called project model. Meaning lectures, seminars and laboratory exercises are finished in 10 instead of 15 weeks. In the last third of the semester, students work on their projects. The course contains two midterm exams. Midterm exams consisted of two parts, a theoretical and a practical part. The total number of points at the 1st midterm exam was 7 points (3 points for theoretical part and 4 points for practical part) and 8 points (4 points for theoretical part and 4 points for practical part) at the 2nd midterm exam. The condition for passing the theoretical part was 1 point and 2 points for the practical part. Students wrote the midterm exams on paper according to predefined rules in 2 groups and 2 halls. Students were randomly placed in the hall by the teachers. Questions on the midterm exams were of the following types "choose one out of offered answers", "choose more from offered answers", "write the missing term", "combine concepts", or "solve short program assignment" and "essay questions". Midterm exam 1 was written in week 6 where the theoretical part had 24 questions and the practical part only 1 programming assignment in HTML and CSS. Midterm exam 2 was written in week 12 where the theoretical part had 19 questions and the practical part only 1 programming assignment in PHP. Student data include the results of all full-time students who wrote midterm exams the first time. Part-time and foreign students are excluded from this research. Course topic learning outcomes were assigned to a particular question of the midterm exam after the AY ended. In other words, after the results of all midterm exams and other activities of the scoring system have been published to students. Tables 2 and 3 show questions (Q) on the

midterm exams. Questions were grouped according to the learning outcome of the course topics. Each learning outcome was assigned to a level (L) according to Bloom's taxonomy.

TABLE 2
MIDTERM EXAM 1 QUESTIONS AND LEVELS GROUPED BY COURSE TOPIC LEARNING OUTCOMES

Internal label of course topic learning outcome	Group 1	Group 2	Level
587-1.1	-	Q6	L2
587-1.3	-	Q7	L2
587-1.4	Q1	Q9	L4
588-1.1	Q16	-	L2
588-1.2	Q20	-	L2
588-1.3	Q11, Q13, Q17, Q22	Q3, Q14	L3
588-1.4	Q2, Q21	Q8, Q11, Q18	L3
589-1.2	Q12	Q23, Q24	L3
589-1.4	Q3, Q4, Q19	P2, Q5, Q17	L3
589-1.5	Q9	-	L3
590-1.2	Q10	Q12	L3
590-1.3	Q15	Q16	L3
590-1.4	Q18	Q21	L3
590-1.5	-	Q10	L3
590-1.6	Q25	Q25	L5
590-1.7	Q24	Q13	L4
590-1.8	-	Q15	L4
597-1.2	Q8, Q14	Q20, Q22	L3
598-1.3	-	Q19	L3
598-1.8	Q6	-	L4
599-1.1	-	Q4	L3
599-1.3	Q7	-	L3
600-1.1	Q5	Q1	L3
600-1.8	Q23	-	L4

TABLE 3
MIDTERM EXAM 2 QUESTIONS AND LEVELS GROUPED BY COURSE TOPIC LEARNING OUTCOMES

Internal label of course topic learning outcome	Group 1	Group 2	Level
593-1.2	Q5, Q11, Q12	Q5, Q11, Q12	L4
593-1.3	-	Q2, Q7, Q9, Q10, Q16	L3
593-1.4	Q2, Q7, Q9, Q10, Q14	Q3, Q4, Q6	L3
593-1.5	Q15	Q15	L3
593-1.6	Q13	Q13	L3
593-1.7	Q1, Q4, Q20	Q1, Q8, Q20	L5
593-1.8	Q3	-	L4
594-1.1	Q6	-	L3
596-1.1	Q8		L3

596-1.2	-	Q14	L3
597-1.2	Q16	-	L3
601-1.1	Q17	Q17	L3
601-1.3	Q18, Q19	Q18, Q19	L3

Previous tables indicate that midterm exams were prepared for verifying course topic learning outcomes at the level L3 and L4 according to Bloom's taxonomy. Number of course topic learning outcomes grouped by levels for each group of the midterm exams were:

- Midterm exam 1 - Group 1: L1(0), L2(2), L3(11), L4(4), L5(1) and L6(0)
- Midterm exam 1 - Group 2: L1(0), L2(2), L3(12), L4(3), L5(1) and L6(0)
- Midterm exam 2 - Group 1: L1(0), L2(0), L3(8), L4(2), L5(1) and L6(0)
- Midterm exam 2 - Group 2: L1(0), L2(0), L3(7), L4(1), L5(1) and L6(0)

The next chapter provides an analysis to identify learning outcomes at the topic level and the reason why students have a hard time to achieve them.

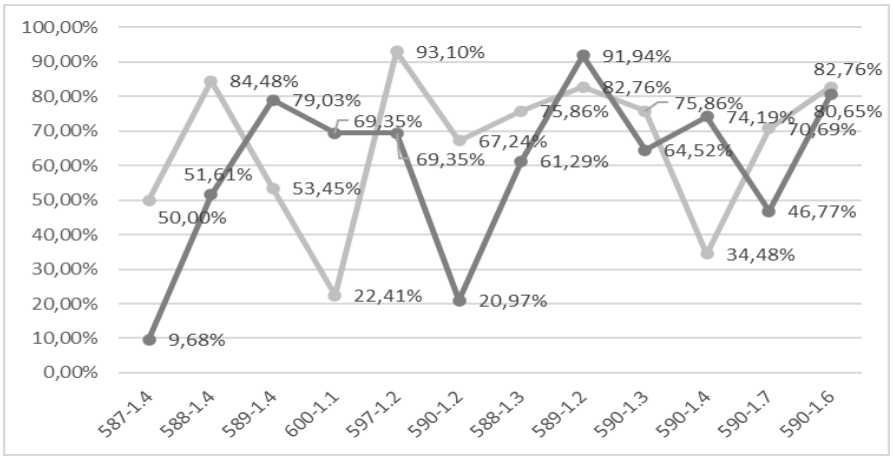
RESULTS

Learning outcomes at topic level were verified with questions in midterm exams. Course topic learning outcomes can be checked with one or more questions. For course topic learning outcomes that were checked with one question the course topic learning outcome was achieved if the answer was correct. If the question had more points, students needed to achieve at least 50% of the points for the course topic learning outcome to be achieved. To achieve a course topic learning outcome that was checked with multiple questions, students had to correctly answer at least 50% of the total number of questions with which that outcome was verified. Total number of students by midterm exam was 120. Group 1 had 58 students and group 2 had 62 students.

Data Analysis for the 1st Midterm Exam

Midterm exam 1 had 24 course topic learning outcomes of which 12 course topic learning outcomes were common in both groups. Fig. 1 shows a comparison of results for course topic learning outcomes between groups of the 1st midterm exam.

FIGURE 1
COMPARISON OF COURSE TOPIC LEARNING OUTCOMES AT THE 1ST MIDTERM EXAM



In Fig. 1 there is a significant difference between groups of certain course topic learning outcomes. For example, 588-1.4 has a lower result in group 2 than in group 1. We could mention that in group 2 this

outcome was checked with 3 questions while in group 1 only with 2 questions. Next 590-1.2 also has a lower result in group 2. Here we have an essay question that had more points.

An overview of the answers shows that most students did not answer this question. Furthermore, the result of 589-1.2 is lower this time in group 1. Students of group 1 had to answer 1 question to meet this course topic learning outcome in relation to students of group 2 that had to answer 2 questions. Table 4 shows the results of other course topic learning outcomes present in the 1st midterm exam.

TABLE 4
OTHER RESULTS AT THE 1ST MIDTERM EXAM

Internal label of course topic learning outcome	Group	Result
587-1.1	G2	79.03%
587-1.3	G2	17.74%
588-1.1	G1	39.66%
588-1.2	G1	74.14%
589-1.5	G1	79.31%
590-1.5	G2	75.81%
590-1.8	G2	59.68%
598-1.3	G2	64.52%
598-1.8	G1	79.31%
599-1.1	G2	29.03%
599-1.3	G1	43.10%
600-1.8	G1	29.31%

Learning outcomes at course level listed in table 4 were checked with one question. Learning outcomes at course level and their question levels of students in group 1 at the 1st midterm exam that were not achieved by the majority of students (<50%) are:

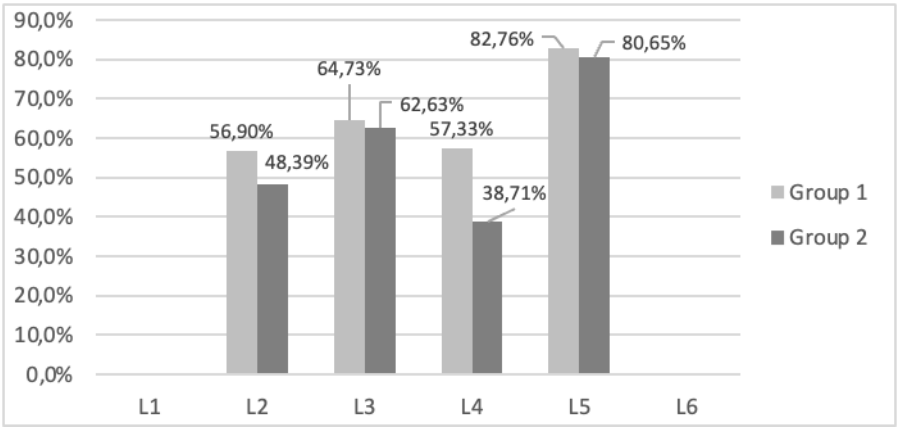
- L2: 588-1.1 - Describe the history of the HTML language and its versions
- L3: 590-1.4 - Distinguish types to write CSS rules
- L3: 599-1.3 - Describe how JS can access and change the properties of objects in a browser
- L3: 600-1.1 - Describe the possibilities of using regular expressions
- L4: 600-1.8 - Describe the features of asynchronous communication in JS (AJAX) using XML and JSON

Learning outcomes at course level and their question levels of students in group 2 at the 1st midterm exam that were not achieved by the majority students (<50%) are:

- R2: 587-1.3 - Explain the properties of the HTTP protocol and structure of requests and responses
- R4: 587-1.4 - Explain the HTTP protocol on a concrete example
- R3: 590-1.2 - Explain the principles of document formatting with CSS
- R4: 590-1.7 - Explain the properties for defining colors in CSS and describe their similarities and differences
- R3: 599-1.1 - Describe the properties and capabilities of the document object model (DOM)

Fig. 2 shows percentages of achieved course topic learning outcomes by group and level of the 1st midterm exam.

FIGURE 2
RESULTS BY LEVELS AT THE 1ST MIDTERM EXAM



The average number of points at the 1st midterm exam in group 1 was 4.20 and in group 2 it was 3.64. Also, according to Fig. 2, group 1 achieved better results than group 2 at all levels. The weakest results were at the level L2 and the level L4. The cause of the lower results at the level L2 is due to questions about HTTP history or basic HTML elements. Level L4 had lower results due to essay questions where students needed to describe the protocol, features, or principles of HTTP, CSS, and JS. A small number of students answered the essay question. Group 1 had 4 course topic learning outcomes defined at level L4 while group 2 at the same level had only 3 course topic learning outcomes. Level L3 had above-average results in both groups. At that level knowledge of the properties, elements, or functions of HTML, CSS, and JS was tested. Group 2 had 12 course topic learning outcomes defined at level L3 while group 1 at the same level had 11 course topic learning outcomes. Level L5 had, as expected the best results due to 1 practical assignment in HTML and CSS that students had to solve to pass the 1st midterm exam.

Data Analysis for the 2nd Midterm Exam

Midterm exam 2 had 13 course topic learning outcomes of which 7 learning outcomes at course level were common in both groups. Students were again randomly placed in the hall by the teachers so that they are not the same students in groups 1 and 2 as there were at the 1st midterm exam. Fig. 3 shows a comparison of results for course topic learning outcomes between groups of the 2nd midterm exam.

FIGURE 3
COMPARISON OF COURSE TOPIC LEARNING OUTCOMES AT THE 2ND MIDTERM EXAM

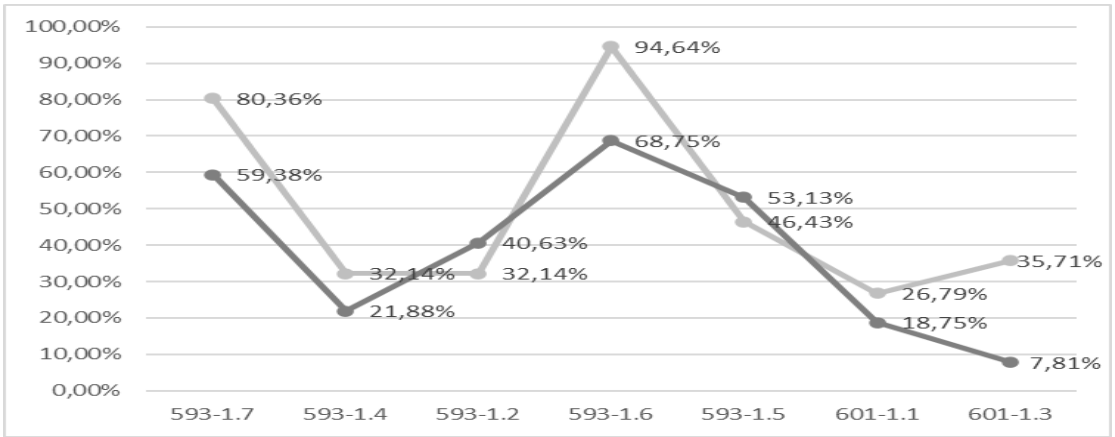


Fig. 3 illustrates an interesting difference between some course topic learning outcomes among groups. Group 2 has a lower result for the course topic learning outcome 593-1.7 compared to group 1. This learning outcome at course level in both groups was checked with the same number of questions (3 questions). Explanation would be that questions aren't graded with the same number of points in both groups. So, if the question had more points, students needed to achieve at least 50% of the points for the course topic learning outcome to be achieved. Group 2 had 1 point less. But regardless of that, both groups achieved an above-average result because 1 question was a practical assignment in PHP that students had to solve to pass the 2nd midterm exam. After that there is the course topic learning outcome 593-1.4 which is again lower in group 2. Reason for the lower result is the fact that this learning outcome at course level was checked with 5 questions in group 1 and with 3 questions in group 2. In other words, to achieve a course topic learning outcome that was checked with multiple questions, students had to correctly answer at least 50% of the total number of questions with which that outcome was verified. Also, the type of questions and the number of points were not the same. On essay questions, students mostly had lower results. Table 5 shows the results of other course topic learning outcomes present in the 2nd midterm exam.

TABLE 5
OTHER RESULTS AT THE 2ND MIDTERM EXAM

Internal label of course topic learning outcome	Group	Result
593-1.3	G2	65.63%
593-1.8	G1	92.86%
594-1.1	G1	50.00%
596-1.1	G1	23.21%
596-1.2	G2	29.69%
597-1.2	G1	71.43%

Learning outcomes at course level listed in table 5 were checked with one question except course topic learning outcome 593-1.3 which was checked with 5 questions. Learning outcomes at course level and their question levels of students in group 1 at the 2nd midterm exam that were not achieved by the majority of students (<50%) are:

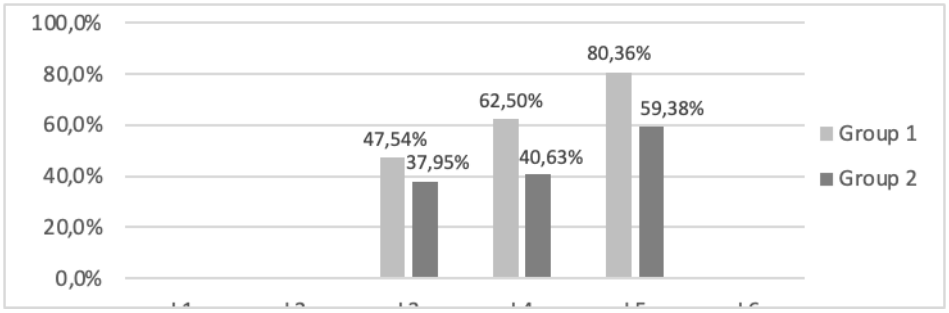
- L4: 593-1.2 - Use of basic instruction in the PHP language for program development
- L3: 593-1.4 - Properly define the name of a variable and constants
- L3: 593-1.5 - Identify common syntax features of PHP and other related programming languages
- L3: 596-1.1 - Apply Smarty PHP template system in web application development
- L3: 601-1.1 - Recognize the importance of web application performance, stress and load analysis
- L3: 601-1.3 - Describe the possibilities provided high availability architectures of Internet systems

Learning outcomes at course level and their question levels of students in group 2 at the 2nd midterm exam that were not achieved by the majority of students (<50%) are:

- L4: 593-1.2 - Use of basic instruction in the PHP language for program development
- L3: 593-1.4 - Properly define the name of a variable and constants
- L4: 596-1.2 - Identify the benefits of applying a template system
- L3: 601-1.1 - Recognize the importance of web application performance, stress and load analysis
- L3: 601-1.3 - Describe the possibilities provided high availability architectures of Internet systems

Fig. 4 shows percentages of achieved course topic learning outcomes by group and level of the 2nd midterm exam.

FIGURE 4
RESULTS BY LEVELS AT THE 2ND MIDTERM EXAM



The average number of points at the 2nd midterm exam in group 1 was 4.66 and in group 2 it was 4.25. According to Fig. 4, group 1 again performed better at all levels than group 2. The lower results were at the level L3 and the level L4. Group 1 has 2 course topic learning outcomes defined at level L4 while group 2 at the same level has only 1 course topic learning outcome. The cause of lower results at the level L3 is due to questions that tests the knowledge of variable properties, correctness of program execution or names of functions in PHP. Questions about the importance of web application performance, stress, and load analysis or high availability architectures of Internet systems were essay questions. Answers of the vast majority of students for the essay questions were very modestly written. Level R4 had slightly better results than level R3 because the knowledge of control structures or program results from PHP was tested. Group 1 deviates a lot from group 2 because it has 1 additional course topic learning outcome at that level. Level L5 had, as expected the best results. This time because of 3 questions, 2 were essays and 1 practical assignment. The practical assignment was in PHP which students had to solve to pass the 2nd midterm exam. Table 6 shows the results of the correlation analysis, which includes the test of initial competencies (T), midterm exam 1 (M1), midterm exam 2 (M2), project (P) and the total number of achieved points in the course (Total). The correlation analysis included all full-time students who wrote the midterm exams for the first time, regardless of whether they failed the midterm exams later or did not submit their project. The structure of the scoring elements is explained in the introduction chapter.

TABLE 6
RESULTS OF ALL STUDENTS

	T	M1	M2	P	Total
T	1				
M1	0.25	1			
M2	0.25	0.74	1		
P	0.20	0.61	0.73	1	
Total	0.24	0.70	0.78	0.96	1

The table shows the positive correlation between the points achieved in the midterm exams and the project that affect the result of the total number of achieved points in the course. The reason for this is that a minimum number of points are required on the midterm exams and the project in order to pass the course. The correlation between the 2nd midterm exam and the project is higher than the correlation between the 1st midterm exam and the project. At the 2nd midterm exam, the entire course material is included in the exam.

In other words, the PHP language which students need the most for their projects. For the same reason, the 2nd midterm exam and the project correlate the most with the total number of points in the course. The weakest correlation is with the test of initial competencies and other scoring elements. Test of initial competencies consists of 6 questions, where 3 questions are about programming (C, C ++) and 3 questions

about databases (SQL). The test is resolved in Moodle at the beginning of the semester and is not included in the total score, which is why it does not significantly affect other scoring elements. Tables 7 and 8 show the results of the correlation analysis that includes levels of course topic learning outcomes (L2-L5) from the 1st midterm exam, the result of the 1st midterm exam (M1), the results of the 2nd midterm exam (M2), the project (P) and the total number of achieved points in the course (Total). Level L2 correlates the least with other scoring elements between groups where level L5 correlates the most.

TABLE 7
GROUP 1 RESULTS AT THE 1ST MIDTERM EXAM

	L2	L3	L4	L5	M1	M2	P	Total
L2	1							
L3	0.41	1						
L4	0.42	0.54	1					
L5	0.49	0.57	0.52	1				
M1	0.47	0.81	0.74	0.80	1			
M2	0.45	0.62	0.64	0.79	0.79	1		
P	0.20	0.33	0.44	0.51	0.53	0.68	1	
Total	0.27	0.44	0.49	0.59	0.64	0.73	0.96	1

TABLE 8
GROUP 2 RESULTS AT THE 1ST MIDTERM EXAM

	L2	L3	L4	L5	M1	M2	P	Total
L2	1							
L3	0.29	1						
L4	0.29	0.49	1					
L5	0.21	0.46	0.31	1				
M1	0.37	0.74	0.64	0.76	1			
M2	0.33	0.47	0.50	0.51	0.71	1		
P	0.36	0.49	0.41	0.48	0.71	0.77	1	
Total	0.39	0.53	0.45	0.53	0.77	0.83	0.97	1

The groups at the 1st midterm exam at level L2 had 2 course topic learning outcomes each, while at level L5 they had 1 course topic learning outcome each. The cause of the high correlation is due higher number of points for the question at level L5 level. There is also a fact that the practical assignment is more important for the project than knowing the history of HTTP and the basic HTML elements.

Group 1 performed better between levels and midterm exams. Group 2 has better results on the project and the total number of achieved points in the course. Tables 9 and 10 show the results of the correlation analysis which includes the levels of course topic learning outcomes (L3-L5) from the 2nd midterm exam, the result of 2nd midterm exam (M2), the project (P) and the total number of achieved points in the course (Total). The tables show that there is a high correlation between level L3, level L5 and the result of the 2nd midterm exam. The main reason for such high correlations is that most of the course topic learning outcomes of the 2nd midterm exam was at the level L3 while questions for the course topic learning outcome at the level L5 had the most points.

TABLE 9
GROUP 1 RESULTS AT THE 2ND MIDTERM EXAM

	L3	L4	L5	M2	P	Total
L3	1					
L4	0.33	1				
L5	0.43	0.37	1			
M2	0.71	0.52	0.77	1		
P	0.55	0.37	0.49	0.67	1	
Total	0.59	0.44	0.51	0.71	0.96	1

TABLE 10
GROUP 2 RESULTS AT THE 2ND MIDTERM EXAM

	L3	L4	L5	M2	P	Total
L3	1					
L4	0.19	1				
L5	0.48	0.29	1			
M2	0.82	0.29	0.67	1		
P	0.63	0.27	0.62	0.76	1	
Total	0.68	0.28	0.60	0.81	0.97	1

Although the level L4 tests the knowledge of control structures or program results from PHP, those questions do not prevail in midterm exam due to fewer course topic learning outcomes. The results of group 2 for the project and the total number of achieved points in the course are also better for the same reason as before stated in the 1st midterm exam.

CONCLUSIONS AND FUTURE WORK

In this paper the results of the midterm exams in the course WebDiP were analysed. The course consists of two midterm exams (week 6 and week 12). Questions in the exams are connected to course topic learning outcomes which test the knowledge and skills of students. The analysis of midterm exams showed that the number of course topic learning outcomes between the levels of each group was not the same. Course topic learning outcomes were assigned to a particular question of the midterm exam after the AY ended.

In other words, after the results of all midterm exams and other activities of the scoring system have been published to students. Type of question with which some course topic learning outcomes were verified also varied between groups. Also, the same categories, of course topics were not included in both groups of the midterm exams. The most common types of question were “write a short answer” and “essay questions”. Based on the conducted analysis between groups of the midterm exams, the conclusion is that it is necessary to better align the categories of questions, types of questions, and the level of course topic learning outcomes. Midterm exams in the academic year 2019/2020 were prepared to avoid earlier stated discovered problems.

Considering the corona pandemic (COVID-19), the theoretical part of the midterm exams in the academic year 2019/2020 were resolved online via Moodle tests. In order to reduce the possibility of cheating by the students and exclude the occurrence of several different types of questions for the same topic within the test of an individual, the midterm exams were divided into several parts. The 1st midterm exams consisted of 5 short tests where the 2nd midterm exam consisted of 6 short tests. The tests could only be accessed at a specific time. The number of attempts was limited to 1. The duration of the midterm exams was 75 minutes. The time limit was 5 to 10 minutes with breaks between tests from 5 to 10 minutes. The questions at the midterm exams were further divided into 1st category, 2nd category and 3rd category

questions. The 1st category of questions had 1 point. The 2nd category of questions had 2 points. The 3rd category of questions had 5 points. The types of questions in the 1st category were "correct/incorrect" and "multiple-choice questions" with only one correct answer. The types of questions in the 2nd category were "write a short answer", "all or nothing multiple-choice" and "matching questions". The type of question in the 3rd category was an "essay question". The number of questions depending on the part of the midterm exam was between 6 and 10 questions. The first parts of the midterm exams had 40% of the questions from the 1st category and 60% of the questions from the 2nd category. The last part of the midterm exam always had 2 questions from the 3rd category. The practical parts of the midterm exams were written at the Faculty when the situation allowed it. All the prescribed epidemiological measures were followed.

Practical parts of the midterm exams were not mandatory in AY 2019/2020 to pass the course. Students who chose to write practical part of midterm exam and passed were further stimulated with extra points on the project. In addition, the practical parts of the 1st and the 2nd midterm exam were not mandatory, so less than 10% of students attended them. In the future work, results from AY 2019 /2020 will be analysed in more detail in order to make adequate changes for the next academic year. A comparison of results for midterm exams results from AY 2019/2020 with the results from the previous academic year will not be possible entirely. Questions for each student at the midterm exams were generated from the question bank. Given that fact there is probably no subset of students who had the same questions in one of the midterm exams.

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