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Introducing Problem-Based Learning to Undergraduate IT Service Management Course: Student Satisfaction and Work Performance

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ABSTRACT

This paper describes the implementation of problem-based learning (PBL) principles in an undergraduate IT service management course, followed by the results about student satisfaction and work performance. The results indicate the students' general satisfaction with the course implementation, as well as some challenges regarding the self-assessment and peer assessment of their work. The findings also reveal the students' better work performance in project results than in traditional knowledge tests, which reinforces the indications about their positive attitudes towards the interactive PBL environment. The cluster analyses identified seven different patterns in student behaviour regarding course performance. Findings from this study could be used by both researchers and practitioners in their efforts to create or further research a stimulating, interactive learning environment based on PBL that improves the preparation of students for their future workplaces.

Keywords: Problem-based learning, student performance, student satisfaction, cluster analysis.

INTRODUCTION AND MOTIVATION

Current predictions about future trends in the demand for information and communication technology (ICT) professionals in Europe present three different scenarios for the period until 2020 (Gareis et al., 2014). In all three cases, the demand potential exceeds the predicted number of ICT graduates. Therefore, the graduate labour market supply and demand has

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emerged as an important issue for research (Atfield & Purcell, 2010; Mourshed, Patel, & Suder, 2013) and has found its place in policy documents as well. Preparing graduates in the ICT field for a successful professional career requires continuous improvement in the educational process and curriculum design (Ali & Aliyar, 2012; Pilgrim, 2013), which includes new teaching methods and collaboration with employers. Innovative teaching methods, such as work-ready learning activities (Costley & Dikerdem, 2012; Litchfield & Sixsmith, 2010; Shukla, Costley, & Inceoglu, 2011), experience-based learning (Matsuo, Wong, & Lai, 2008), practice-based learning (Hynes, Costin, & Birdthistle, 2011), cooperative education programmes (Coll, Zegward, & Hodges, 2002), problem-based learning (PBL) (Intayoad, 2014) and so on, are increasingly finding their place in formal education.

The general aim of this paper is to provide a framework for organising and implementing a curriculum for an IT service management course, respecting the principles of (PBL) and related practices. The framework encompasses the definitions of all the main curriculum elements, including curriculum aims, intended learning outcomes, course content, learning and teaching methods and assessment (McKimm, 2007). The description of implemented framework is followed by the analysis of student satisfaction with certain curriculum elements implemented according to PBL principles, amended with the analysis of different patterns in students' behaviour regarding the assessment of their work performance during the course. In line with these research goals, the authors have proposed two research questions:

1) How do students assess particular aspects of this set learning environment, organised according to problem-based learning principles?
2) Is it possible to identify specific patterns in students' work performance in the established problem-based learning environment?

First, the paper brings short theoretical introduction on PBL principles, followed with the description of their implementation in IT service management course. In the Methodology chapter, we described two different methods used to answer the research questions – semantic differential scale for the assessment of different aspects of IT service management course organized according to PBL learning environment and cluster analysis for the identification of different patterns in students' work performance. Paper is concluded with the extensive Discussion of the results and implications for further research.

THEORETICAL BACKGROUND

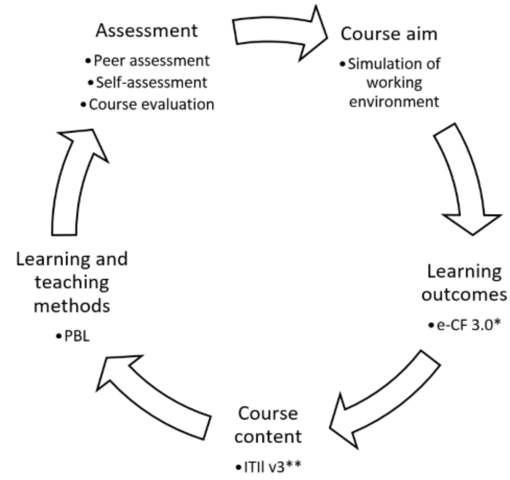
This chapter contributes to the understanding of problem-based learning principles and provides detail explanation of IT service management curriculum elements.

Problem-based learning

Problem-based learning is a student-centred instructional approach (Popescu, 2012) that involves valorising the problems from the “real world” in the educational process to facilitate the development of students’ critical thinking and problem-solving abilities and the assimilation of the fundamental concepts for different academic disciplines (Draghicescu, Petrescu, Cristea, Gorghiu, & Gorghiu, 2014). The PBL process sets goals for students to plan, communicate their ideas, gather information and implement and evaluate projects with real-world applications (Domínguez & Jaime, 2010) and are thus critical for learners in higher education to acquire genuine experiences (Heo, Lim, & Kim, 2010). Some authors describe PBL as the shift from traditional educational approaches to innovative ones that encourage lifelong, collaborative, student-centred and self-regulated learning (Baturay & Bay, 2010) and as such, contribute to the development of the students’ necessary skills for their future workplaces. The relevant literature has also recognised the positive influence of PBL methods on the development of students’ generic and transferable skills to fulfil the needs of the 21^{st}-century job market, such as problem solving, creativity, teamwork and critical thinking, among others (Ersoy & Başer, 2014; Hung, Hwang, & Huang, 2012; Musa, Mufti, Latiff, & Amin, 2011, 2012; Şendağ & Ferhan Odabaşı, 2009). From the students’ point of view, PBL contributes to improvements in terms of learning, motivation, enjoyment, involvement, teamwork quality and overall satisfaction, but it also increases their study time and effort compared with traditional learning (Popescu, 2012). Since PBL tasks refer to real-world problems, they are usually too complex for individual work and imply co-operation among students in the form of teamwork. In this manner, PBL often integrates co-operative learning (Heo et al., 2010) and can thus be described as an interactive learning environment based on real-world problem solving.

Implementation of PBL in IT service management course

To successfully achieve the positive effects of PBL, it is important to respect the principles of good PBL when planning the course organisation. This section describes the IT service management undergraduate course that was offered at the University of Zagreb, Faculty of organization and Informatics during the 2014–2015 academic year and attended by 140 regular students. At the end of the course, 115 students fulfilled all the course requirements although not all of them achieved the minimum score for a passing grade, which was 51 out of 100. The course description includes the main curriculum elements (Figure 1): its aims, intended learning outcomes, course content, learning and teaching methods and assessment, each of which is described in more detail in this section.



* European e-Competence Framework 3.0.
** Information Technology Infrastructure Library (ITIL) framework v3

Figure 1. IT service management curriculum elements.

Course aim

The course's main aim was to teach students the management approach to IT service development, including not only the technical point of view but also the business perspective. The course was organised into 30 hours of lectures and 30 hours of laboratory exercises over a 17-week period. The main idea behind organising the course exercises was to put students in a similar environment to the one experienced in the real professional world, through the simulation of IT service development and communication processes with potential clients. The students were divided into teams of three or four members, each team representing a small IT company ('virtual company') with a task to develop an innovative IT service. In (Pažur Aničić and Mekovec 2014), we reported about the students' positive attitudes towards this kind of course organisation, as well as their increased motivation associated with the work in this type of learning environment. At the end of the course students were expected to deliver the prototype of the mobile or web application as the final product of their work, together with the related business documentation.

Course content, learning outcomes and performance plan

The course content was organised in line with the well-known Information Technology Infrastructure Library (ITIL) framework based on best practices in IT service management, *for the governance of IT and the management and control of IT services* (Cartlidge et al., 2011). The ITIL v3 service life cycle encompasses five stages: service strategy, service design, service transition, service operation and continual service improvement, which were used as guidelines for the development of the IT services performed by the students' virtual companies. The main learning outcomes of the course exercises were to enable students to:

1) work in a virtual company and define/perform all necessary steps in planning the new IT service,
2) prepare and participate in business meetings with potential clients and
3) design and present a prototype of their IT service.

Owing to the defined learning outcomes, the exercises were based on only two phases of the ITIL service life cycle – service strategy and service design. Each week, the course started with a two-hour lecture, introducing students to the theoretical knowledge related to the tasks and assignments to be performed during the upcoming exercises. To show the students the usefulness of certain skills and knowledge obtained for their potential professional profiles, the learning outcomes for each task within the exercises were connected to the European e-Competence Framework 3.0. (e-CF) (European Comitee for Standardization (CEN), 2014), as well as to generic competencies (Lokhoff et al., 2010).

With only goals and guidelines in front of them, through the implementation of PBL in the IT service management course, the students were encouraged to develop their generic and transferable skills, desired to fulfil the needs of the 21st-century job market. The teacher's role in this process was to moderate and direct the students' work to achieve the set goals. Most of the work was organised to be carried out during the 2-hour laboratory exercise each week since the opportunity to collaborate face-to-face within teams was necessary for a successful project output. Additionally, because ICT was perceived as useful for supporting students' teamwork (Heo et al., 2010), their collaboration was supported by the learning management system (LMS) Moodle, which contained all the materials necessary for a successful project output, as well as provided a "collaboration corner" for each team.

Teaching methods using PBL approach

To implement PBL concepts in the course, it was necessary to consider whether the idea would meet the requirements of a good PBL problem. According to (Duch, 2001), a good PBL problem should:

1) engage students' interest and motivate them to understand the context of the problem,
2) require students to make decisions/judgements based on the introduced principles or information,
3) be complex enough that a solution requires the co-operation of all team members,
4) include open-ended questions at the first stage of a problem and/or draw all team members into the discussion and
5) incorporate the course's content objectives into the problem, with a mandatory connection of previous knowledge to new concepts, as well as new knowledge to the concepts in other courses.

Furthermore, a good PBL problem (Lohman, 2002) has the following characteristics:

1) The problem should be unclear, and the information needed to solve it should be incomplete.
2) There should be more than one way to solve the problem.
3) The problem should not have a single right answer.

Another recommendation is that it should be intentionally complex, ill-structured, open-ended and have a holistic view of the problem or situation (Kolodner, Hmelo, & N. Hari, 1996). Moreover, collaboration of students or groups of students is a necessity, and the problem should also define the students' roles and goals. The positive aspects of a good PBL can be summarised as follows: "*An added benefit, if problems fit the criteria listed, is that, in general, they will require students to integrate knowledge from across multiple disciplines*" (Kolodner et al., 1996). Table A.1 in Appendix 1 lists the characteristics that the relevant literature associates with a good PBL problem, explaining the implementation of each characteristic in the IT service management course.

Assessment of students' work and course in general

The students' work was evaluated through two different types of activities during their course work: 1) 60 points for the individual knowledge obtained, as assessed through three tests during the semester, and 2) 40 points for teamwork, earned through project work. Altogether, five performance measurement attributes had effects on the students' final grade, namely, Test 1 (T1), Test 2 (T2), Test 3 (T3), project work – phase 1 (P1) and project work – phase 2 (P2). The students could also obtain 20 points for self-assessment (SA) and 20 points for peer assessment (PA), which were excluded from the final grade and used only as an experimental method for using SA and PA in interactive learning environments, which students were aware of. At the end of the semester, the students evaluated the results of their own work (SA) in the second project phase (presented as an application prototype in the form of a video through Wiki pages in Moodle). They also evaluated the results of their peers' work (PA), using the same criteria implemented in the form of rubrics in Moodle. Each student individually was randomly assigned two other projects to evaluate – they knew whose project they are evaluating, but they were also aware that the evaluated students would not know who of their peers have evaluated their work. The idea behind involving SA and PA was to determine how the scores obtained for both correlate with the students' performance in the project work, as assessed by the teacher, and with their individual success in theoretical knowledge tests. The relevant literature shows some work on the use of SA and PA by university student colleagues, stressing the issues that teachers deal with when including SA and PA as part of formal assessment. Regarding the positive aspects, PA activities are found to stimulate students to initiate critical thinking and provide objective judgements about the quality of the work being evaluated, as well as to offer constructive comments about possible improvements in future work (Yu & Wu, 2011). On the other hand, PA demands considerable time and effort from the teacher to organise and manage the assessment process (Chen, 2010). During the entire teaching process, monitoring by teachers is important to avoid particular members' low level of collaboration and involvement in teamwork (Popescu, 2012). In fact, the efforts put into the project are not always shared equally by all team members. Other authors have recognised this problem in the existing literature on teamwork; consequently, they emphasise the need for improving the assessment methods in PBL (Fernandes, 2014).

Aside from the assessment of students' work, their satisfaction is an essential issue that should be considered when the perception of course quality or course content, as well as course effectiveness, is evaluated. The results presented by (Liaw & Huang, 2013) indicate that the learning activity could be affected by environmental characteristics, environmental satisfaction and learner characteristics. Therefore, we have also incorporated individual students' evaluation of different course aspects at the end of the semester, using the self-created semantic differential scale.

The methods and results of student performance and course satisfaction, both related to the assessment phase in the curriculum design, are described in the next section.

METHOD

Student satisfaction

At the end of the course, the students were given the opportunity to anonymously express their satisfaction with the laboratory exercises organized according to the PBL principles. A total of 123 students, of which 107 (87%) were male and 16 (13%) were female, filled the questionnaire about their satisfaction with certain course aspects. Most of the students (66%) stated that their initial interest in this course was medium, 21% assessed their interest as high, and 13% considered it low. The students were also asked to estimate the effort they put into the course completion on a five-point Likert-type scale (from 1=minimum effort to 5=maximum effort). Only two students (1.6%) assessed their effort as minimal, and 10.6% considered it very low. Most of the students (44%) stated their effort as medium, and another 44% reported it as high (32.5%) or very high (11.3%).

For the assessment of the students' general satisfaction with some aspects of interactive learning environment implemented within the laboratory exercises of the IT service management course according to the PBL principles, we used a self-created scale similar to the one proposed by (Lin, 2008), consisting of (1) several general questions showing the students' attitude towards the course and the work performed and (2) the semantic differential scale with a five-point Likert-type scale for the assessment of six aspects of the learning environment. The semantic differential scale, a technique for evaluating people on their responses to pairs of bipolar adjectives in relation to concepts, has been found to be appropriate for the evaluation of experiential teaching methods (Whitney & Soukup, 1988). Different aspects of the learning environment were assessed, using the same semantic differential scale with the following eight pairs of attributes: usual–innovative, boring–interesting, motivating–demotivating, challenging–unchallenging, low quality–high quality, appropriate–inappropriate, unnecessary–necessary and useless–useful. The questionnaire was first piloted in the same course during the 2013–2014 academic year (Pažur Aničić and Mekovec, 2014), when many PBL elements were already implemented.

Table A.1. brings the connection between characteristics of a good PBL problem and their implementation in IT service management course. With the analysis of student satisfaction we wanted to see how satisfied are students with the course implemented according to PBL principles in the following aspects of learning environment:

1) content of laboratory exercises (related to the ITIL v3 concept),
2) teaching methods (teamwork – each team representing a virtual IT company, students given basic instructions only for task completion, the teacher with the role of instructor and only providing guidance to students on their tasks),
3) simulation of work environment (business meeting, contracting and maintenance, assigning roles in the company, determining job vacancies within the company),
4) collaboration with employers (visiting lecturers from several IT companies, practical examples of potential project implementation, presentation of students' final projects in front of company representatives),
5) future career development (insight into the labour market, meeting the standards of the profession – e-CF 3.0., preparation of motivation letter) and
6) Moodle (usage of this LMS to support all course activities).

Students were not expected to evaluate the implementation of certain PBL principle in the course, as it is something they are not familiar with. But they indirectly evaluated it through expressing their satisfaction with six aspects of learning environment which are directly affected with PBL principles. Those aspects refer directly to the implementation of PBL principles, but also stimulate students to think about the connection of this type of learning activities with the world of work and the impact to their future career development.

Table C.1 in Appendix C shows the average values, standard deviation and Cronbach's alpha coefficient for each of the six evaluated aspects of the learning environment. The Cronbach's alpha coefficient for the internal consistency of the scale for each aspect, assessed by eight pairs of attributes, is quite acceptable, ranging from 0.868 to 0.926. Figure 2 shows that the students' assessments of all aspects of the learning environment are on the right, positive side of the semantic differential scale. The students gave the highest ratings to collaboration with employers (M=4.438, sd=0.603) and simulation of the work environment (M=4.137, sd=0.722) in the regular exercises. All the other aspects were rated above average, showing the students' positive attitudes towards the content of the exercises that were structured in line with the ITIL best practices (M=3.836, sd=0.67), methods used in the teaching process in line with PBL (M=3.776, sd=0.747), activities connected with their future career development and labour market needs according to e-CF 3.0 (M=3.830, sd=0.745), and usage of Moodle to support teaching activities and the students' group work (M=3.640, sd=0.779).

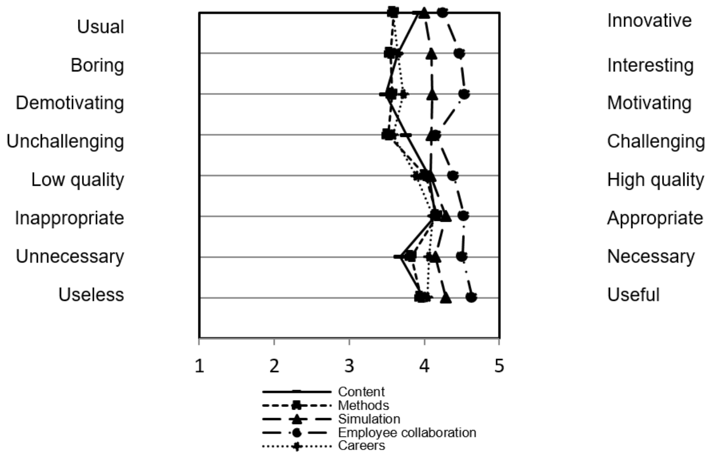


Figure 2. Students' assessment of different course aspects.

To gain better insights into the results, we analysed the effects of the students' initial interest in the course and their efforts in the course completion on the six aspects of the learning environment that were of interest. Table C.2 in Appendix C presents the descriptive statistics for the dependent variables (aspects of the learning environment). Generally, it could be observed that the students with lower initial interest in the course assessed all the course aspects with slightly lower values. The situation was similar with the students who put less effort into performing the course tasks although it was not always the case for the students who rated their efforts 3 points or higher on the five-point Likert-type scale (from 1=minimum effort to 5=maximum effort). To determine if there were statistically significant differences in the effects of the initial course interest and work effort among different groups, we performed the analysis of variance (ANOVA). The test scores indicated no statistically significant differences among the groups regarding the effects of different levels of initial interest and work effort, except in a few cases. There was a significant effect of work effort on the students' assessment of the teaching methods used in the course (df=4, F=3.121, p=0.0179), showing that those who put less effort into the course assignment completion reported lower satisfaction with the teaching methods. Initial interest (df=2, F=15.336, p=1.33e-06) and work effort (df=4, F=3.373, p=0.0121) both showed a significant difference in the students' attitudes towards the aspect of their future career development, indicating that those with lower interest and work effort did not perceive the importance of their future career at this stage of their study. The students' interest in the course also had a significant effect on their attitudes towards the use of Moodle in the teaching process (df=2, F=5.675, p=0.00451).

Work performance patterns

Besides students' satisfaction with the particular aspects of learning environment set according to PBL principles, another research question is related to the identification of students' work performance patterns in the introduced PBL environment. To identify different groups of students in the set learning environment (in terms of their work performance), the hierarchical clustering algorithm was applied in the statistical package R. Five performance measurement attributes were used (T1, T2, T3, P1 and P2) for clustering, amended with the SA and PA results. The clustering algorithm resulted in seven clusters (C1–C7), as shown in Figure 3, with the descriptive data (mean and standard deviation) in Table B.1 in Appendix B.

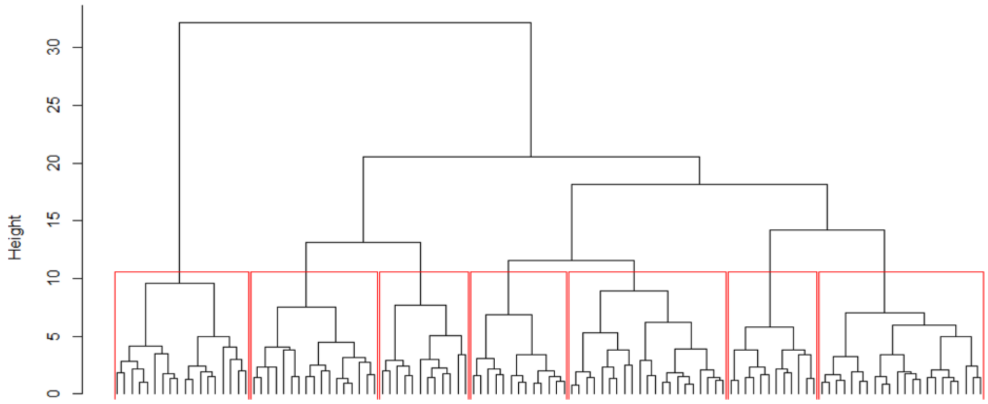


Figure 3. Clusters based on students'work performance.

Cluster 1

Cluster 1 consisted of 18 students with an overall score (M=55.78, sd=5.32) lower than average (M=65.10, sd=9.18). The students included in this cluster had lower performance in individual tests (T1, T2 and T3), as well as project work (P1 and P2) results that were slightly lower than average. Their peers assessed (PA) their project work as lower than average (M=8.67, sd=3.09), but they evaluated their own work (SA) as much higher (M=13.67, sd=2.03) than their peers and teachers did (M=12.06, sd=2.51). Better scores in T3 indicated the students' intention to obtain enough points for a passing (or higher) grade at the end of the semester.

Cluster 2

Cluster 2 comprised 21 students with a lower than average final score (M=60.51, sd=5.75) but higher than that in Cluster 1 (M=55.78, sd=5.32). The students in this cluster obtained lower than average test results in all three tests (T1, T2 and T3), near average project results for the first phase (P1) and above average scores for the final project (P2) phase. These outcomes indicated that the students in this group were more practically than theoretically oriented, but their general performance was quite low. They seemed aware of the low efforts they put into the course tasks because their SA results (M=13.57, sd=2.50) were lower than those of the PA (M=14.31, sd=1.61) and their P2 grades received from the teachers (M=14.43, sd=3.84).

Cluster 3

In Cluster 3, 12 students obtained a higher than average overall score (M=73.09, sd=6.36). This group's main characteristic was that the students assessed their final project work (SA) with much higher grades (M=18.08, sd=2.53) than those given by their peers (PA) (M=14.88, sd=2.55) and teachers (P2) (M=14.50, sd=2.96). For the members of this group, the negative correlation between the first two tests (T1 and T2) and the project work results (P1 and P2) showed that the students were either practically oriented and thus put more effort into the project work than in the theoretical tests (which would explain their high SA scores) or were assigned to teams in which some members worked more on the project results. Their above average results (M=16.09, sd=1.54) in the last test (T3) indicated their efforts to obtain a better final grade towards the end of the course.

Cluster 4

For the 17 students included in Cluster 4, their overall course score was above average (M=60.57, sd=6.98), and their project work was much better assessed in the second phase (P2). On the other hand, their test results were below average for all three tests (T1, T2 and T3), with very low results in the second test (T2) (M=9.41, sd=2.46). The higher score obtained in the final project phase clearly showed that the students had been working harder on their project in the second phase. However, they seemed unrealistic in the SA of their own work (M=17.94, sd=1.89), which was higher than those obtained from their teachers (P2) (M=15.18, sd=2.46) and peers (PA) (M=16.82, sd=2.51).

Cluster 5

The main characteristic of the 22 students in Cluster 5 was their achievement of higher scores in individual knowledge tests (except T2) than in project teamwork (P1 and P2), which differentiated them from the students in the other six clusters. The SA (M=13.05, sd=1.17) and PA (M=14.09, sd=2.66) of their final project work were similar to their teachers' assessment (P2) (M=13.96, sd=2.17). Of all the clusters, this group's overall course success (M=64.82, sd=5.91) was closest to the average course success for all clusters (M=65.10, sd=9.18).

Cluster 6

Cluster 6 consisted of 13 students with an above average overall score (M=71.58, sd=3.98) and higher scores in project work (P1 and P2) than in individual theoretical knowledge (T1, T2 and T3). The fact that the students evaluated their work (SA) lower than their teachers did implied that either these students put less effort into teamwork than the other team members did and were aware of it, or they put more effort into project work than the tests and were very self-critical. Both their PA (M=13.50, sd=1.94) and SA (M=15.39, sd=2.76) evaluations were lower than their teachers' (P2) (M=18.23, sd=1.42). It is important to note the really low scores obtained from their peers, which is hard to interpret.

Cluster 7

Cluster 7 included 12 students showing the highest course scores (M=79.10, sd=4.44), with higher than average results for four of the five assessment aspects, except T2, which was slightly below average. From the much lower SA results (M=13.00, sd=3.49), which differed significantly from the PA (M=16.54, sd=2.37) and the teachers' assessment (P2) (M=17.25, sd=2.09), it could be concluded that the students in this group were very self-critical. The possible explanation for this case was that they put more effort into theoretical foundations, not only into project work, giving them a broader theoretical background about the problem they were solving and making them more conscious about possible improvements in their own work.

DISCUSSION AND CONCLUSION

In this paper, we presented a framework for introducing PBL principles in the IT service management course. One of the major changes introduced to the PBL elements in the course is connected with teachers' and students' roles (Roberto & Ribeiro, 2008) in this new form of an interactive learning environment. Teachers are responsible for guiding students in their process of problem solving and therefore assume the role of consultants, as well as facilitators of students' learning. For their part, students are responsible for learning and proposing solutions to the introduced problem. This discussion is organised around several main findings referring to the research questions related to different patterns of the students' work performance and their satisfaction with the introduced learning environment, taking into account this study's limitations.

First, let us discuss the answer to the first research question: *How do students assess particular aspects of this set learning environment, organised according to problem-based learning principles?* The answer to this research question was obtained by the use of semantic differential scale for the assessment of student satisfaction with six course aspects: 1) content of laboratory exercises, 2) teaching methods, 3) simulation of work environment, 4) collaboration with employers, 5) future career development and 6) usage of this LMS Moodle to support all course activities. The general conclusion about the students' satisfaction with the six learning environment aspects, organised according to PBL principles, was found to be very positive. It is interesting to see that students were most satisfied with the collaboration with employers (M=4.438, sd=0.603) and simulation of the work environment (M=4.137, sd=0.722) within the course, which indicates their positive attitude to the connection with the world of work within regular courses. We can connect our research results of students' satisfaction with certain aspects of learning environment organized according to PBL principles with the positive results of some previous researches on PBL implementation. For example, (Popescu, 2012) showed that, from the students' point of view, PBL contributes to improvements in terms of learning, motivation, enjoyment, involvement, teamwork quality and overall satisfaction but increased their study time and effort compared to traditional learning. This can be related to the significant effect of work effort on the students' assessment of the teaching methods used in our course (df=4, F=3.121, p=0.0179), showing that the students who put less effort into the course assignment completion expressed a lower level of satisfaction with the teaching methods.

Second, within the implementation of the PBL environment, we wanted to research the different patterns in the students' work performance and the SA and PA characteristics through the rubrics in the Moodle workshop. That was researched by the application of cluster analysis and provides an answer to the research question: *Is it possible to identify specific patterns in students' work performance in the established problem-based learning environment?* Cluster analysis resulted in seven different groups of students according to their work performance. Although both teachers and students were introduced to increased time/workload needed for the adaptation to the new learning environment within laboratory exercises organized according to PBL principles, it is noteworthy that the average scores for all three tests (T1=12.56, T2=10.61 and T3=13.53) were lower than those for the project work results (P1=14.72 and P2=15.09). These results indicated the students' positive attitude towards project-based teamwork in solving real-world problems compared to individual theoretical knowledge. As the project-based learning organized according to PBL principles is also based on some theoretical foundations (in this concrete case it is the ITIL v3), it would be interesting to further research if students also better learn and gain theoretical knowledge from this type of activity, comparing to the classical ex-cathedra lectures. If further research shown that this kind of problem-solving teamwork contributes to the development of the necessary skills for the students' future workplaces, both theoretical knowledge and practical skills, it should be considered that the practical part of the course work is weighted with a stronger factor in the course's overall point structure than the strictly theoretical knowledge tests.

Besides providing an answer to the second research question, cluster analysis also provided some insight into the application of student self-assessment and peer-assessment in the courses organized according to PBL principles. The results on the use of SA and PA also indicated different patterns in student behaviour. Although not directly addressed in the research questions of this paper, we will refer shortly to these results as well, since they indicate a potentially interesting area for further research on the assessment within PBL as one of the main curriculum elements described in the theoretical part. In other research studies, using rubrics in the portfolio assessment showed a significant difference between SA

and teacher assessment but no significant difference between SA and PA (Chang, Tseng, & Lou, 2012). Generally, our results found similar values for P2 (M=12.35, sd=3.23) and SA (13.37, sd=2.48), while PA was much lower (M=10.29, sd=2.92) but with differences from cluster to cluster. This confirmed previous findings that PA failed to demonstrate acceptable validity if the teacher assessment was used as a valid exterior criterion (Chang et al., 2012), and it could not be used as a reliable assessment method (Chang, Tseng, Chou, & Chen, 2011). For example, for Clusters 1 and 3, PA was much lower than P2. It can be concluded that PA and SA are recognised as positive and central techniques to develop critical aptitudes in students (Wright, 2011), but they require control from the tutor (Martínez-González & Duffing, 2007). On the other hand, self-evaluation points out two main patterns: 1) students who assess their own work higher than its realistic score, such as in Clusters 1, 3 and 4, and quite the opposite, 2) students who are really self-critical and rate their work much lower in comparison with their comprehensive work performance, similar to those in Cluster 7.
The main limitation in our approach was the anonymous questionnaire with the semantic differential scale, so we were unable to observe the relationships between the students' satisfaction with the set learning environment in line with PBL principles and their work performance. In future research, it would be interesting to find out how students' initial interest and work effort correlate with their work performance. We used the anonymous questionnaire mainly because we wanted to obtain honest responses from the students, which would have been a problematic issue if we had asked them to write their names in the completed questionnaires before they obtained their final course grades.

As for the conclusion, we would like to refer to the introduction, which indicated the importance of the implementation of new teaching methods in courses, in order to better prepare students for the world of work. One of the main roles of higher educational institutions is to educate future professionals in a certain field and to provide them with the knowledge and skills desired by their future employers. The existing literature has shown that the interactive PBL environment offers the possibility to motivate and promote students' awareness and responsibility for their learning, with respect to the development of their professional skills and attitudes. Our work represents a framework for implementing PBL principles into IT service management course that could serve as guidelines for other practitioners willing to implement PBL principles in their courses. The interactive PBL environment positively influences students' self-directed learning and could therefore be used to narrow the gap between the student profiles desired by business organisations and the profiles currently offered by higher educational institutions. Except describing in detail teaching methods organized according to the PBL principles, this study's results contribute to the last phase of the curriculum cycle, the assessment phase, by indicating the potential for the use of self-assessment and peer-assessment methods.

The presented research contributes to several areas of improvement in teaching practices. First, gaining insights into student satisfaction with particular course elements can be helpful in the further innovation of a particular course or study programme. In this way, students can benefit from modern and creative courses that simulate the actual work environment to solve real-world problems. They can also learn about some techniques to be used in their future professional work. Furthermore, the paper contributes to the individualised approach in course development and delivery, based on the recognition of different students' work performance patterns. When teachers possess information about the patterns in students' work performance in the set learning environment, they can adapt certain course elements to the needs of specific groups of students. This strategy enhances creativity, critical thinking and the development of other transferable and employability skills. Consequently, the results of this research offer valuable inputs in the necessary process of narrowing the gap between current students' skills (developed during education) and the skills desired by employers. Therefore, this study's findings could be used by both researchers and practitioners in their efforts to create or further research a stimulating, interactive learning environment based on PBL that improves the preparation of students for their future workplaces.

Appendix A. Description of PBL elements

Table A.1. Characteristics of a good PBL problem and their implementation in IT service management course.

Characteristic of PBL problem introduced in IT management course	**How was it implemented?**
The problem engages students' interest and motivates them to understand the context of the problem (Duch, 2001; Kolodner et al., 1996)	Organising the course exercises aimed to present students with real-world situations in which they would be active participants. Students attending our faculty and this course would be employed in the information and communication a low grade in technology (ICT) domain. Therefore, new knowledge about the organisation and management of IT companies would be welcomed upon completion of their education process and during their job search. Moreover, students were encouraged to choose a problem according to the teams' previous knowledge and interests to make them more motivated to work on its solution.
The problem requires students to make decisions/judgements based on introduced principles or information (Duch, 2001).	In the beginning of every exercise, students were introduced to the set goals. Furthermore, possible ways of achieving defined goals were presented, and students were requested to consult particular information sources to learn more about how to conduct a particular analysis or compilation, for example. Additionally, during the organised lectures by invited speakers from different IT companies, students were introduced to real problems occurring in such companies on a daily basis or at a particular phase of service development. This was an opportunity to familiarise themselves with the development of services based on presented practice. Consequently, they were able to apply the obtained information in their own virtual companies.
The problem is complex enough that a solution requires the co-operation of all	Owing to the time limitation, the tasks connected to the particular exercises, as well as the overall course goals, were too complex to be solved by one student during a given time period (each exercise

members of the students' teams (Duch, 2001; Kolodner et al., 1996; Weiss, 2003)	lasted for 90 minutes, performed 14 times during the semester). To complete all necessary activities, students were required to communicate within the group and to work as a team.
The problem includes open-ended questions (Duch, 2001); (Kolodner et al., 1996).	During the first week of the semester, the student teams should have agreed on the type of company they would operate and the new IT service they would introduce to the marketplace. For a successful decision, this process required the consensus of all team members. All team members were also expected to be familiar with all the defined processes in their virtual company. Dealing with open-ended questions was most pronounced during the simulation of business meetings with the potential clients, which were organised two times during the semester. The purpose of these meetings was to introduce students to common business communication, as well as to prepare them to different aspects of service presentation. During the meeting, the students played their respective roles in their company and were required to negotiate with a new client about questions from their own domain, without having previously prepared the list of questions to be discussed with a potential client.
The problem is unclear (Lohman, 2002); in some studies, this type of problem is defined yet ill–structured (Baturay & Bay, 2010; Kolodner et al., 1996; Weiss, 2003)	As already mentioned, students were encouraged to choose a problem on their own, and the teachers' role was to judge if the problem would be adequate to satisfy all the learning outcomes of the course. Thus, the problem was not based only on a particular discipline and previously defined. In the beginning of each exercise, students were provided with information regarding the goals of particular exercises, the connection with previous work and the connection with the overall goals of the course. Students were invited to apply their current knowledge, such as implementing a SWOT analysis or defining the graphical standard of a mobile application. They were also introduced to tools, methods and techniques that could be used for performing the exercise tasks and attaining the goals. They were not given a definition of a specific output since there was no ideal solution for each project.
There should be more than one way to solve the problem (Lohman, 2002). The problem should have several interpretation/solutions (Baturay & Bay, 2010; Kolodner et al., 1996)	During each exercise, students were introduced to a new element of service development. Various methods, techniques and tools that could be used to efficiently complete defined tasks were presented. The student teams could choose how they would act and which methods and tools they would use; therefore, various solutions to the same task were possible.
The information provided is incomplete (Lohman, 2002).	During the first business meeting, students presented their ideas on their new IT service to sell it to the potential clients (their teachers). In this negotiating process, the sellers (students) attempted to capture all the client requirements. The clients were demanding various modifications of the presented product/service. Before the meeting, students were informed about its purpose only, but they were unfamiliar with their potential clients' identities and requirements. Moreover, during the meeting, students were required to be very careful about how they would react to client demands because their task in the second cycle of the exercises was to implement and deliver their final service prototype according to what was negotiated.
The connection of previous knowledge to new concepts, as well as new knowledge to the	To solve a particular task, students needed to use their previous knowledge. New concepts, which were expected to be learned through a particular exercise, were referenced on students' previous

concepts in other courses, is mandatory (Duch, 2001; Weiss, 2003)	knowledge, as well as on possible future usage during their graduate studies. For example, students were introduced to the scope of the SWOT analysis during their previous work in other courses, and in this course, they were required to apply the SWOT analysis to their virtual company that was placed in a concrete business environment. On the other hand, the final prototype produced during this course could be used as input for further work in other courses (e.g., mobile application development).
Teachers are only facilitators and consultants; the students' role is to work on the problem (Baturay & Bay, 2010).	Teachers were not using the usual techniques, such as presentations or the conference method, during the exercises, but students were provided with theoretical knowledge during the lectures. Instead, teachers were only giving instructions to students on how a particular task could be solved, and their primary role was to discuss with students about their problems in the company and future steps in their service development. In this manner, teachers assumed the consultant's role for all virtual companies and helped students examine the problem with a more realistic and business view.
Students are motivated towards lifelong and self-directed learning (Weiss, 2003); they evaluate their own work (Baturay & Bay, 2010).	One of the activities carried out during the semester was the analysis of current job offers on the real ICT market. Students had the task of comparing their current knowledge and skills with those recurring in job profiles. In this way, students were motivated to make plans regarding their future professional career. They were also encouraged to assess their own work and compare it to those of their peers through self-assessment and peer-assessment activities.

APPENDIX B: Results of clustering

Table B.1. Descriptive statistics for all clusters

	Overall		**C1 (18)**		**C2 (21)**		**C3 (12)**		**C4 (17)**		**C5 (22)**		**C6 (13)**		**C7 (12)**	
Element	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
T1	12.56	3.49	10.19	2.20	9.74	2.60	14.88	3.57	12.21	2.28	14.36	2.34	11.27	1.90	15.29	2.24
T2	10.61	3.04	7.47	2.67	9.45	1.75	10.71	3.17	9.41	2.46	10.21	1.42	13.39	1.34	13.63	2.60
T3	13.53	3.62	13.73	2.58	12.23	2.02	16.09	1.54	10.84	1.91	14.11	1.42	12.85	1.65	14.85	2.57
P1	14.72	3.21	12.33	3.50	14.67	2.10	16.92	2.63	13.00	3.84	12.18	3.54	15.85	2.91	18.08	1.56
P2	15.09	3.23	12.06	2.51	14.43	3.84	14.50	2.96	15.18	2.46	13.96	2.17	18.23	1.42	17.25	2.09
PA	14.12	2.92	8.67	3.09	14.31	1.61	14.88	2.55	16.82	2.51	14.09	2.66	13.50	1.94	16.54	2.37
SA	14.96	2.48	13.67	2.03	13.57	2.50	18.08	2.53	17.94	1.89	13.05	1.17	15.39	2.76	13.00	3.49
Overall course score	65.10	9.18	55.78	5.32	60.51	5.75	73.09	6.36	60.57	6.98	64.82	5.91	71.58	3.98	79.10	4.44

APPENDIX C: Evaluation of different course aspects

Table C.1. Descriptive statistics of students' satisfaction with different course aspects

	Content		Method		Simulation		Employee		Career		Moodle	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Usual – Innovative	3.992	0.835	3.959	0.936	4.285	0.835	4.642	0.642	4.041	0.872	3.870	0.941
Boring – Interesting	3.683	0.961	3.829	0.894	4.146	0.929	4.512	0.761	4.065	0.894	4.098	0.900
Demotivating – Motivating	4.146	0.856	4.171	0.786	4.285	0.741	4.528	0.631	4.114	0.812	3.992	0.864
Unchallenging – Challenging	4.057	0.771	4.016	0.839	4.081	0.836	4.390	0.785	3.886	0.851	3.829	0.989
Low quality – High quality	3.764	1.064	3.520	1.089	4.098	0.962	4.154	0.984	3.577	0.950	3.407	0.931
Inappropriate - Appropriate	3.488	1.011	3.569	0.933	4.106	0.847	4.545	0.668	3.724	1.011	3.366	1.010
Unnecessary – Necessary	3.642	1.017	3.553	1.026	4.098	0.962	4.480	0.813	3.650	1.008	3.301	1.032
Useless – Useful	3.919	0.845	3.593	1.055	4.000	0.950	4.252	0.874	3.585	0.958	3.260	1.055
Cronbach's Alpha	0.868		0.910		0.926		0.903		0.922		0.921	

Table C.2 Means and SDs of dependent variables

		Interest			Work	
		Mean	**St.Dev**		**Mean**	**St.Dev**
Content	1	3.555	0.428	1	3.063	0.442
	2	3.849	0.658	2	3.596	0.636
	3	3.971	0.790	3	3.734	0.667
				4	4.009	0.613
				5	4.071	0.737
Method	1	3.492	0.543	1	2.625	0.000
	2	3.792	0.751	2	3.490	0.658
	3	3.904	0.820	3	3.757	0.708
				4	3.997	0.701
				5	3.652	0.903
Simulation	1	3.844	0.691	1	3.438	0.088
	2	4.117	0.705	2	4.019	0.775
	3	4.380	0.739	3	4.007	0.747
				4	4.341	0.630
				5	4.268	0.747
Employee	1	4.375	0.631	1	3.563	0.265
	2	4.471	0.521	2	4.625	0.445
	3	4.375	0.811	3	4.317	0.691
				4	4.541	0.528
				5	4.563	0.424
Career	1	3.219	0.693	1	3.375	0.530
	2	3.790	0.675	2	3.663	0.035
	3	4.332	0.675	3	3.727	0.709
				4	4.088	0.629
				5	3.714	0.797
Moodle	1	3.172	0.929	1	3.188	0.619
	2	3.628	0.711	2	3.288	0.979
	3	3.966	0.759	3	3.567	0.681
				4	3.825	0.748
				5	3.786	0.953

Legend: For the variable Interest, 1=small, 2=medium, 3=high
For the variable Work, 1= minimum, 2=very small, 3= medium, 4= high, 5=maximum

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