TEAM WORK DEVELOPMENT ACROSS THE CURRICULUM FOR INFORMATION TECHNOLOGY STUDENTS AT LIEPĀJA UNIVERSITY: PROCESSES, OUTCOMES AND LESSONS LEARNED

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Abstract. *Teamwork skills are key feature for Information Technology (IT) specialists. The university IT curriculum contains both IT specific courses, and comprehensive courses. Due to limited amount of the learning courses and efficient achievement of learning goals, it is necessary to look for opportunities to integrate activities developing social and communication skills courses into IT specific courses. Managing the teamwork that is close to practice, it is necessary to solve the problems of teaching and learning organisation, and assessment of individual learning outcomes and competences. In Liepāja University, the student teamwork has been managed for several years as integral part of Software Engineering courses and study projects. The course management system Moodle has been used in learning process providing possibilities to evaluate both assignments submitted by students and their learning behaviour. The current paper describes and analyses the experience of academic staff of Liepāja University.*

Keywords*: assessment, blended learning, Computer-Supported Collaborative Learning, e-learning, generic competences, teamwork.*

Introduction

Social collaboration, characterized by mutual peer-to-peer and student-to-mentor relations, plays a significant role in teaching and learning process. Effective communication and teamwork are two important generic skills requirements for successful engineers (Kashefia, 2012). The teamwork competency is highly valued by organizations that need cooperation between their members in order to achieve their objectives (Iglesias-Pradas et al., 2014).

Soft skills (such as teamwork, verbal and written communication, time management, problem solving, and flexibility) and personal attributes (such as risk tolerance, collegiality, patience, work ethic, identification of opportunity, sense of social responsibility, and appreciation for diversity) play a critical role in the workplace. Successfully applying technical knowledge in practice often requires an ability to tolerate ambiguity and to negotiate and work well with others from different backgrounds and disciplines. These overarching considerations are important for promoting successful professional practice in a variety of career paths (ACM/IEEE-CS, 2013).

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In organizational environments, group evidence and its identification are usually measured, and its knowledge and structure are used in the professional accreditation concerning the teamwork competences (Salas et al., 2013). Accreditation Board for Engineering and Technology (ABET) has emphasised teamwork skills in the criteria for accrediting engineering programs of universities and colleges (Lingard, 2010). So, Computing guidelines states that graduates must demonstrate "an ability to function effectively on teams to accomplish a common goal" (ABET, 2014).

Collaborative learning becomes popular in higher education. Most popular form of collaborative learning is computer-supported collaborative learning. Universities try to integrate collaborative learning in study process because of promises to involve students in more active learning. "Many educators are discovering that online platforms can be used in order to provide the solution to problems in groups, and to develop communication skills whilst the students' knowledge is increased" (Horizon, 2014).

The cooperative model proposes that learning is produced more successfully when small groups of students share information and debate it together. Doing so in groups allows them to build mental models and, therefore, knowledge (Vogel et al., 2001). Collaborative learning means that there is not only collaborative activities like discussion topic but this collaborative task is place for active learning and interaction. E-learning environments, like Moodle, offer a lot of activities that can be used for collaborative learning: wiki, discussion forum, seminar, chat and others (Ulmane-Ozolina, 2011). It is widely accepted that students should build their own knowledge in an active manner (Alexander, 2006).

The collaborative learning model, represented in Fig.1, put together Tuckman's group development model (Smith, 2005) and learning individual and teamwork activities. The model demonstrates the meeting points of collaborative learning in three levels – teacher, team and individual student.

(Sfard, 1998) offers two metaphors for teaching and learning – an acquisition and the participation approach. Acquisition approach put main focus on textbooks and study resources to support acquisition and partly on the teaching skill of lecturer. Key aspects of an acquisition approach to learning include knowledge, fact, concept, and attainment, the having of knowledge. In the participation metaphor main focus is on the nature of learning in belonging, participating, communicating, and becoming a member of a community. Both metaphors are effective for higher education just have to carefully balance.

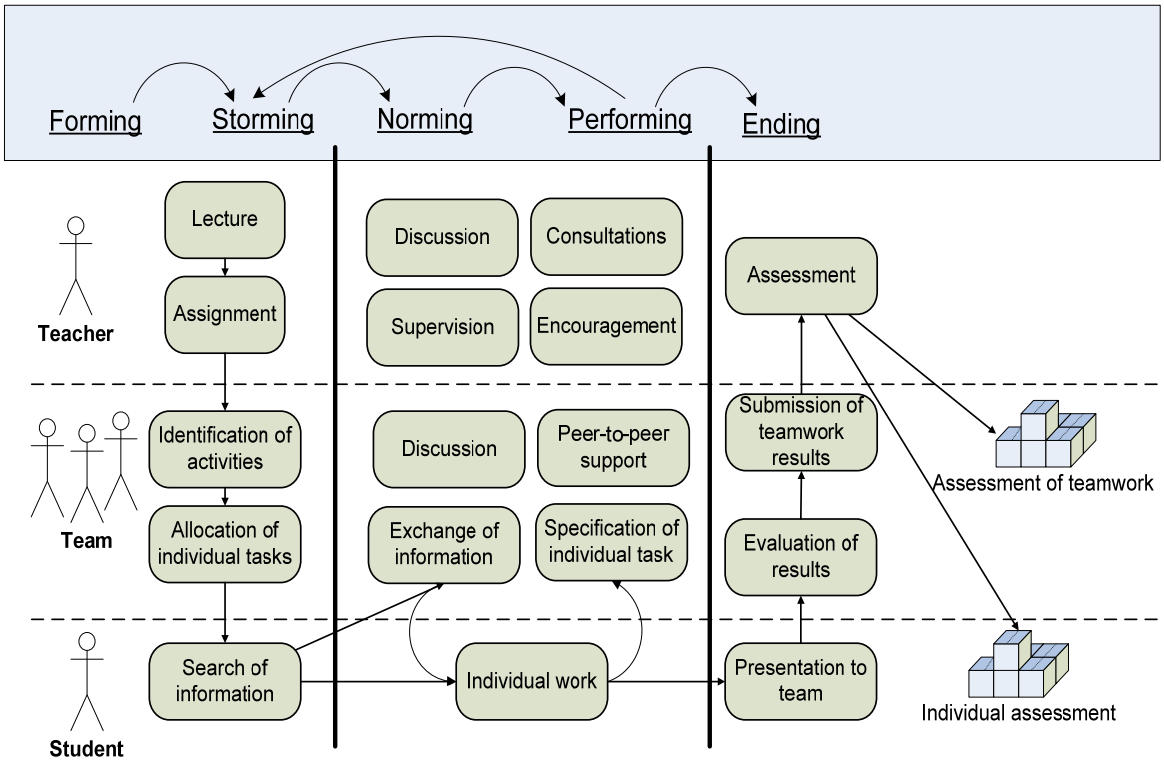

Figure 1. Tuckman's group development model and students' teamwork organization

Many universities include the teamwork competences in their study programs and, therefore, should do the teamwork assessment to verify the extent to which such competency is acquired by means of evidence (Fidalgo-Blanco et al., 2015). The development of teamwork leaves evidence of three types: individual (participation, cooperation, monitoring, leadership, efficiency, etc.), group (mission and objectives, standards, map of responsibilities, etc.) and results (Perez-Martinez et al., 2014). The Fig. 2 represent the model of students individual and teamwork learning efforts resulting in team project deliverables and students' individual final grades. The most crucial problem in teamwork assessment is evaluation of individual contribution of each team member. It can be assessed by peer-to-peer evaluation (performed by each team member), by students self-evaluation, and analysing learners behaviour basing in information provided by logfiles of Learning Management System (LMS).

Students' self-evaluation and peer-to-peer evaluation surveys are the most common used tools for monitoring and assessing development of teamwork competences (Jansone, 2011). In order to carry out the monitoring and individual evaluation in a teamwork context, various tools have been developed: surveys that measure the perception of students, self-evaluation questionnaires and peer-to-peer evaluation. (Perez-Martinez et al., 2014).

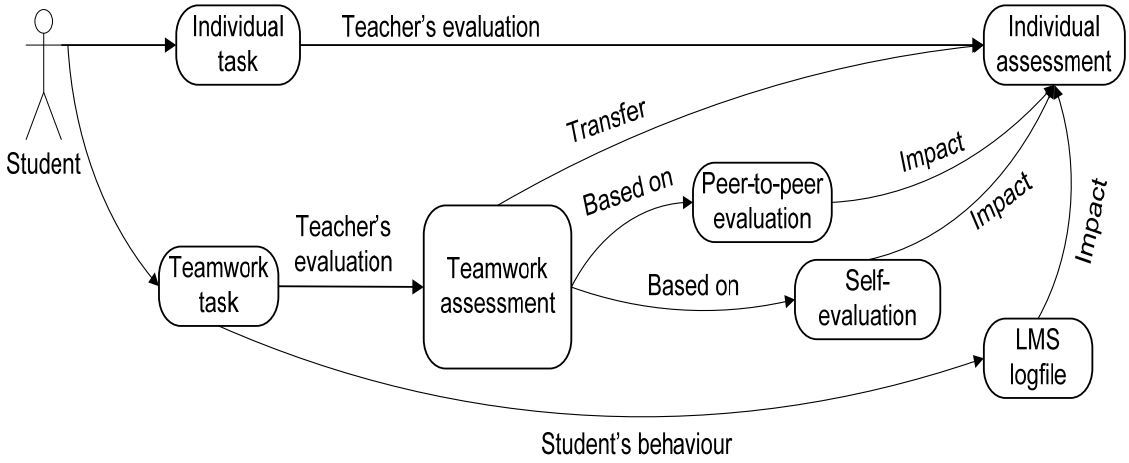

Figure 2. Student's individual assessment in context of teamwork

Besides, the number of interactions throughout the teamwork processes directly influences the outcomes of the learning within the teamwork. Therefore interactions can be considered as indicators in order to evaluate the teamwork process. (Fidalgo-Blanco et al., 2015). Previous studies on the influence of different types of user interactions, in learning contexts based on IT show that the number of interactions is related with learning results. (Agudo-Peregrina et al., 2014).

A Learning Management Systems (LMS) provide data about student-to-system interactions. The student-to-content interactions take place primarily in the wiki and the content management system, associated with the group and result evidence (Fidalgo-Blanco et al., 2015). LMS store quantitative data about forum interactions. These data act as a tool that helps in the prediction, intervention and decision making. In general, an additional processing of information is required so that it may be useful for individual evaluation of the teamwork competences.

However, the monitoring individual evidence in the teamwork and evaluating its performance requires a great deal of time for the teaching staff (the effort should be multiplied by the number of students), because monitoring and assessment of the individual evidences require a qualitative analysis of all of the interactions in the virtual learning environment (Fidalgo-Blanco et al., 2015).

Based on the above rationales regarding teamwork and development of generic skills, the following research hypotheses are defined:

Hypothesis H1. The student teamwork activities have positive effect on learning outcomes of software engineering courses.

Hypothesis H2. There is a correlation between student activity in teamwork-supported virtual learning environment and his/her individual learning success.

Method

In order to carry out the empirical analysis 16 students from Liepāja University were selected and grouped into 5 project teams, i.e.., 3 to 4 members in each team, among second year Computer Science and Information Technology undergraduates (academic year 2014-2015).

The teams have been working the whole academic year (two terms) with learning tasks of several Software Engineering courses, i.e., Software Project Management (SMP), Database Management Systems (DBMS I, DBMS II), Information Systems Analysis and Design (ISAD), Object-Oriented Analysis and Modelling (OOAM), and Software Quality and Testing (SQT). At the end of the academic year, the teams should submit and present the completed web-based database project, including running software code, data structures, and full documentation, such as Software Project Management Plan (SPMP), System Operational Concept Description (SOCD), Software Requirements Specifications (SRS), Software Design Description (SDD), Software Description (SWD), Software Test Documentation (TST), Software User Documentation (SUD), etc. Fig. 3 represents the framework of the Software Engineering courses and deliverables of students' software project. The teamwork concludes with application and presentation of students' annual projects that includes the software project documentation and other deliverables developed by the teams.

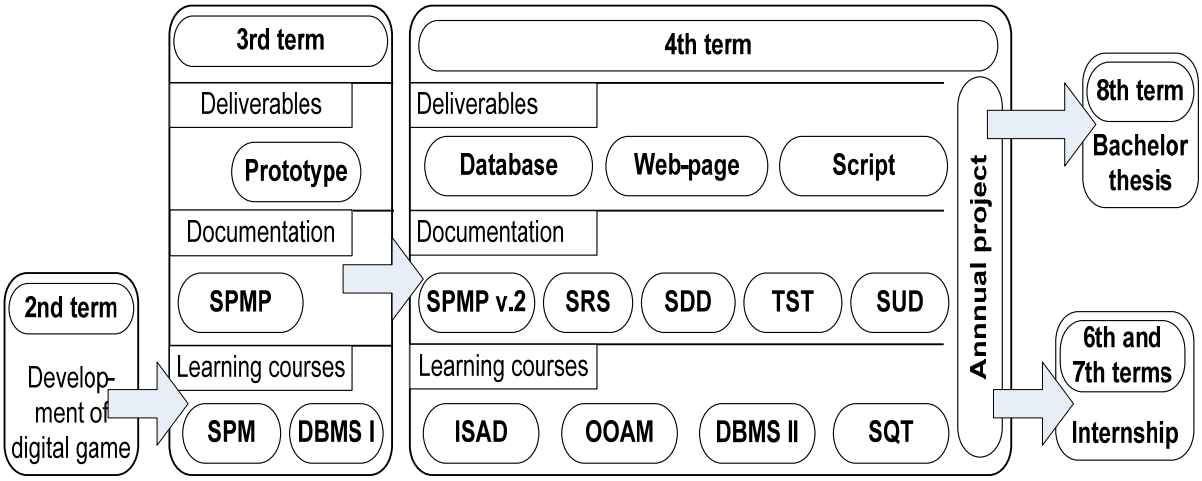

Figure 3. Software Engineering courses and deliverables of students' software projects

Before starting the Software Engineering projects in second year, the students have some previous experience of teamwork at the end of the first year (second term) when they develop the digital educational game project. The first year project provides possibilities for the students to apply knowledge and skills of programming, web-design, computer graphics and animation, and multimedia.

Hence student's teamwork skills had been assessed in several courses and study project. The grades are calculated from different assessments based on teamwork outcomes. Besides the teamwork tasks, each student should complete set of individual assignments. The student's final individual assessment is combination of teamwork and individual assessments. All outcomes teamwork and individual assignments have been submitted and stored in Course Management System (CMS) Moodle. The research study is based on analysis of Moodle logfile data describing user behaviour in virtual learning environment and individual learning performance.

In addition, a self-evaluation survey has been conducted in middle of fourth term to evaluate effectiveness of the teamwork. The survey contains two groups of questions: (a) one group for self-assessment of students' communication and teamwork skills, (b) another group for self-assessment of teamwork effect on learning of Software Engineering courses. A five-point Likert scale has been used for each question providing rating from strong agree to strong disagree.

Results

The CMS Moodle provides information about the individual interaction of student and resources of virtual learning environment. The information provided by the Moodle describes time of access the learning resource, and name and kind of the accessed resource. So, during the first term, the 16 students (5 teams) created 11,892 clicks in the Moodle course Software Project Management. Table 1 presents the statistics of team activities in virtual learning environment

Table 1. Descriptive statistics of team activities in virtual learning environment

Clicks by all students		**Clicks by team leaders**		**Clicks by rest team members**	
Average	***Standard deviation***	***Average***	***Standard deviation***	***Average***	***Standard deviation***
353.05	145.15	453.40	113.24	283.90	80.50

In order to test the suitability of information provided by CMS Moodle logfiles as predictor of students' individual performance (research hypothesis H2), the correlation between the student individual activities in virtual learning environment and their success rate was calculated. For the current studies, the Spearman's rank correlation has been used. In order to evaluate team leaders effect on learning outcomes of their teams, the correlation coefficient has been calculated twice: (a) for all students and (b) for students excluding leaders data. In the context of the current studies, the team leader is student made most number of click in CMS Moodle among his/her teammates. Table 2 presents two coefficients of Spearman's rank correlation between individual grades and clicks made by students in Moodle.

Table 2. Spearman's rank correlation between individual grades and clicks made by students in Moodle

Grades to clicks (by all students)	Grades to clicks (by all students, excluding team leaders)
0.5464	0.7091

In order to test the research hypothesis H1 of the current studies, several steps has been completed. At first, using CMS Moodle logfiles, average grade of individual assignments and average grade of teamwork assignment for each student have been calculated. Fig. 4 represents the results of the given calculations. It is easy to observe that assessments of teamwork tasks are higher than assessments of individual tasks for all students.

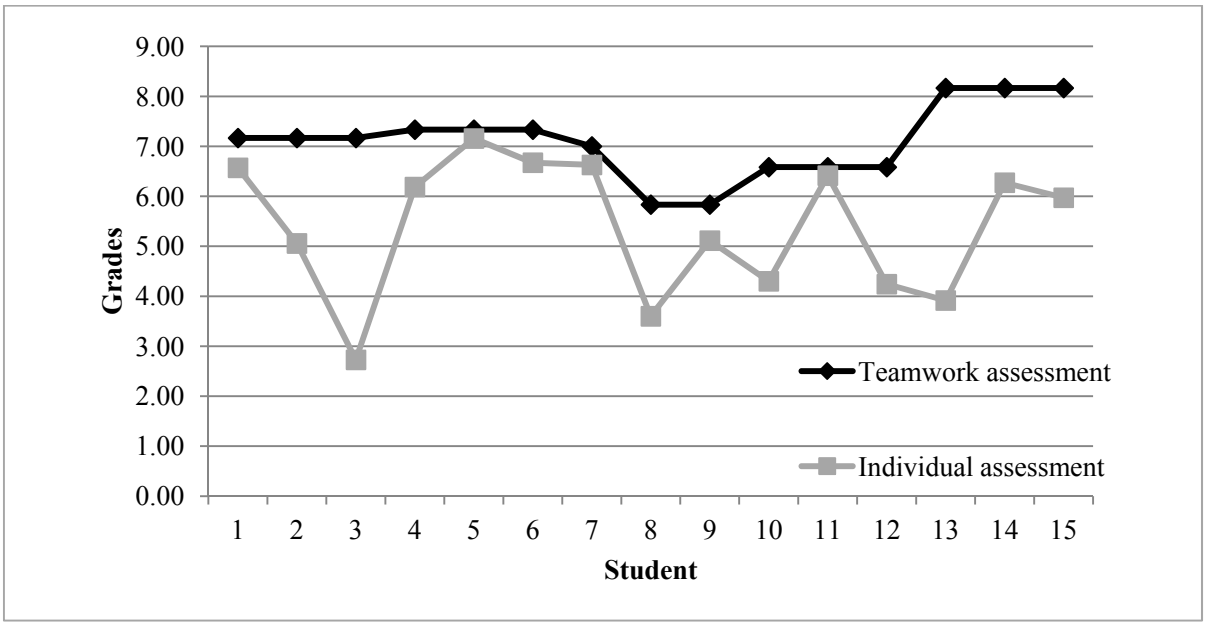

Figure 4. Teamwork and individual assessment

Basing on the previous observation, the t-test has been used to test the statistical hypothesis: (a) null hypothesis – "average grades for teamwork and individual tasks are similar", (b) alternative hypothesis – "average grades for teamwork and individual tasks have significant difference". Table 3 presents the results of the hypothesis testing.

Table 3. Statistics for hypothesis testing on teamwork and individual assessment

Grades of teamwork tasks		Grades of individual tasks	
Average	7.094	Average	5.389
Variation	0.544	Variation	1.832
$t_{\alpha,\nu} = 0.063$; t-value = 4.287 $\alpha = 0.95$; $\nu = 28$; H_0: $\mu = \mu_0$; H_A: $\mu \neq \mu_o$			

Discussion

On the basis of the obtained results, the main conclusion is that the student teamwork activities have positive effect on learning outcomes of software engineering courses. It is argued both by data represented in Fig. 4, and by test of statistical hypothesis (see Table 3), and by students' self-evaluation survey. In Fig. 4, the average grades of teamwork tasks are higher than grades of individual tasks for each student. The use of t-test confirms the observations statistically. It can be argued by positive influence of teammates, higher individual responsibility on teamwork deliverables, and complimentary effect of peer-to-peer learning, mutual support, and influence of other social factors. In informal interviews, some of the students points out that they are slightly afraid to cause inconvenience to teammates, and therefore they put additional effort in order to complete their individual task in teamwork in required time frame and with acceptable quality.

In overview, the students recognize that "teamwork supplements knowledge and skills acquired in Software Engineering courses" and "promotes understanding of relationships between different Software Engineering courses". They agree that during the completion of teamwork assignments the mutual knowledge sharing had taken the place. The students have contradictory opinions on "the need for additional instructions on teamwork". Part of students confirms the necessity, but other ones reject that. All students agree that "virtual learning environment provides necessary tools for teamwork".

The results or the current studies demonstrate that there is a correlation between student activity in virtual learning environment and his/her individual learning success. The values of Spearman' rank correlation coefficients in Table 2 confirm this statement. Slightly higher value is obtained if team leaders have excluded from calculations. The reason is that the team leader should perform additional activities for managing teamwork and submitting deliverables of the teamwork. These additional activities of weak (as learner) team leader do not cause better assessment.

The authors of the current studies accept the potential critics on reliability of the results of the current analysis do to small number of measurements. However, the similar studies have performed more than five years, and informal interviews with students and their self-evaluation survey in previous years indicates the same results.

Conclusions

Due to the demand for developed teamwork competences of university graduates teamwork activities have been playing more essential role in Computing programs. Even though the importance of communication and teamwork skills is well understood, finding the efficient teaching methodology and reasonable ways of evaluation of teamwork skills is big challenge.

The assessment of teamwork competences cannot be based only on the results of team activities. It is necessary to assess also individual activities of each student and in an objective manner to evaluate individual contribution to production of team deliverables. One way doing so is the use of data describing learners' behaviour that are stored in logfiles of Learning Management Systems. The current study confirms relation between students' active interaction in LMS and their learning outcomes.

In addition, the current analyses argue that teamwork improves students' communication skills and advances knowledge of theoretical background of learning content.

The further studies will focus on looking for the more efficient ways how to improve individual assessment in context of teamwork and development of software tools for analysis of learners' behaviour.

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