ACTIVE LEARNING ENVIRONMENT SCALE-UP AND EDUCATIONAL MODEL

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Abstract. The article reviews SCALE-UP (The *Student-Centered Activities for Large Enrollment Undergraduate Programs*) active learning environment and *Cloud Computing* technologies *Enabled Active Learning* know-how, the main requirements for a SCALE-UP type classroom and educational model. Transfer of this good practice of equipping two SCALE-UP classes at Kaunas University of Applied Sciences is discussed. This article presents the modelling case for Software Engineering Course lectures and practical activities. Three phases are underlined for each topic: 1) the problem based learning; 2) practical activities by tutoring; 3) collaborative learning. The lectures and practical work are combined and executed as a whole in the frame of SCALE-UP study plan and an active learning scenario. The classroom is equipped with a virtual workplace, cloud computing services, open resources on the Internet, e-libraries and subscribed databases. The study results considering the assessment of collaborative learning outcomes and the use of cloud computing technologies are discussed.

Keywords: Collaborative active learning, Cloud Computing technologies Enabled Learning, SCALE-UP learning environment.

Introduction

The new approach to teaching and learning in higher education is no longer directly related to systematically organized studies. Teaching is viewed as the process which enables people to develop their knowledge, understanding, abilities, values, attitudes and experience. The implementation of this idea is concurrent with learning environments which put emphasis on equipping students with effective and interactive learning tools and devices that correspond to the student's learning habits and needs. The question is: what kind of technological and educational conditions and innovations will be needed to achieve that? What learning environments have to be created and what learning technologies need to be chosen in order to improve students' perception of conceptual (theoretical) subject-matter, their ability to solve problems, learning outcomes and motivation? The problem of creating learning environments has been researched by numerous foreign and Lithuanian scientists [1, 8, 9, 11]. Conventional lectures, when the study material is uploaded and easily available in the virtual environment, is becoming less than effective method of teaching. At Kaunas University of Applied Sciences, the availability of study material in virtual learning environments has generated the need to modify conventional lectures by integrating active learning methods [1].

Active learning means the student's active participation in the learning process [4]. Active learning involves the most advanced thinking skills such as analyzing, synthesizing, and assessing [3]. Another distinctive feature is interactivity defined by the interaction between the student and the lecturer, between students, the student and the subject-matter, and the student and tools needed to accomplish the task [10]. In order to achieve such level of interaction and student activity, it is necessary to appropriately reconstruct the physical space in relation to the virtual learning environment. Successful examples of such reconstruction are SCALE-UP[28] (*Student-Centered Activities for Large Enrollment Undergraduate Programs*) and TEAL[29] (*The Technology Enabled Active Learning*) projects.

Since 2010 Kaunas University of Applied Sciences has been developing the environment of active collaborative learning as based on the good practice of SCALE-UP and TEAL projects.

The article discusses the practice of developing the active collaborative learning environment by setting up studio-like SCALE-UP classrooms at Kaunas University of Applied Sciences while making use of the already existing e-learning infrastructure and MS Visual Studio software tools for visualization, simulation, experimentation and designing.

The aim of research: to analyze the case practice of active collaborative learning environment and cloud computing technologies enabled active learning while modelling the contents of the Software Engineering study subject.

[28]SCALE-UP. Retrieved from https://www.researchgate.net/publication/266882822_Student-Centered_Activities_for_Large-_Enrollment_University_Physics_SCALE-UP

[29]TEAL at MIT. Retrieved from http://web.mit.edu/8.02t/www/802TEAL3D/teal_tour.htm

The subject of research: SCALE-UP active collaborative learning environment.

The methods of research: analysis of scientific literature, case study, survey.

Good practice SCALE-UP and TEAL projects

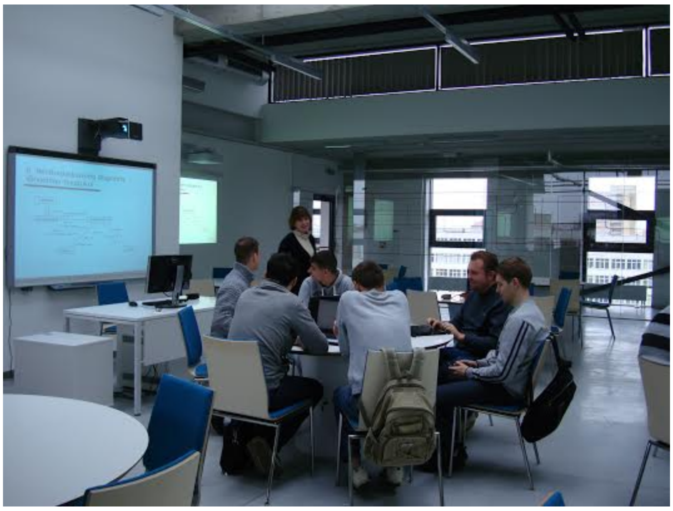
SCALE-UP is a learning environment created to stimulate active collaborative learning in a studio-like classroom [6]. The requirements for such environment were shaped during the implementation of the SCALE-UP project at different universities including North Carolina State University (USA). The project aims to develop a collaboration-based, the student-centered activity, technologically equipped interactive learning environment designed for study course stream lectures (50-100 students) [7]. The project was developed as an alternative to traditional, lecturer-centered type of lectures; it included the creation of a new didactic model for teaching physics, chemistry, and biology based on the integration of lectures and laboratory practice; the reconstruction of physical environment (classroom); and preparing of study material. The main achievements of the project: improved understanding of conceptual (theoretical) material; more positive approach to studies; increased motivation; improved learning outcomes and augmented problem solving abilities; decreased student drop-out rates [2].

SCALE-UP classrooms are furnished with round tables for groups of nine students. Each student is equipped with an Intel i5 computer with a touchscreen. The lecturer uses a laptop with wireless Internet connection. There is a 47" Full HD screen for every student team. All screens are synchronized. The classroom equipment enables to display the picture from any computer in a classroom. Students have access to the Internet; they can carry out experiments using laboratory equipment and/or the computer, discuss in larger or smaller groups, and demonstrate the obtained results on a screen for a joint discussion. The classes follow an educational model based on student discussions and collaborative learning; student activity prevails over lecturing; there is individual instructing and joint discussing of activity results. One of the best known examples of SCALE-UP adaptation is the TEAL project for physics studies at Massachusetts Institute of Technology (MIT). The TEAL (*The Technology Enabled Active Learning*) model features: short lectures; visualization; process imitation/simulation; experimentation using laboratory devices and tools; collaborative learning. The studies at TEAL classrooms are notable for collaborative learning in small groups, instructing, experimentation and data display on a computer screen, simulation of different physical processes, and the use of assessment tools for interactive study achievements. The distinctive features of the MIT TEAL project are the visualization and simulation of physical processes. Both animation and interactive JAVA based programs were used to implement the project[30]. Later on numerous interactive tools were prepared for teaching a mathematics course at a TEAL classroom[31]. SCALE-UP active learning environments are being adapted at many universities in the USA, the UK, Portugal, Sweden, Norway, France and other countries.

Setting up SCALE-UP classes at Kaunas University of Applied Sciences

The first SCALE-UP classroom at Kaunas University of Applied Sciences was set up in October 2010. There are four round tables of six computerized workplaces – for the total of 24 students and one computer-equipped workplace for the lecturer. There is a wireless Internet connection. Students can also use their personal computers. Students are able to perform individual or group tasks, demonstrate the results and discuss them in groups or together in the classroom; they can show the results from their workplace via the video projector. All the course material prepared by the lecturer is available in the virtual learning environment Moodle of Kaunas University of Applied Sciences. For group work students can use the possibilities provided by Kaunas University of Applied Sciences Google Apps[32]. Students can also use other open study sources available on the Internet. The lecturer has a possibility to demonstrate the course material via the smart board or make use of the screens equipped in the room while providing explanations or tasks for separate student groups [1]. The SCALE-UP project at Kaunas University of Applied Sciences is being continued. In October2014 the second SCALE-UP classroom was opened (pic. 1).

[30] Physics 8.02 - Electricity & Magnetism. Retrieved February 18, 2017, from: http://web.mit.edu/8.02t/www/802TEAL3D/
[31] TEAL at MIT. Retrieved September 30, 2014, from http://web.mit.edu/8.02t/www/802TEAL3D/teal_tour.htm
[32] Kauno Kolegija/University of Applied Sciences Google Apps. Retrieved from: http://mail.go.kauko.lt/



Picture 1. SCALE-UP classroom at Kauno Kolegija / University of Applied Sciences (photo by Jūratė Lukšaitė)

The classroom has 17 round tables of 6 workplaces with three laptops. Students can bring and use their own laptops or tablets. The classroom will seat 102 students; there is also a computer-smart board equipped workplace for the lecturer. There are six screens placed around the perimeter of the room. The lecturer can use his workplace to demonstrate the material via all screens; students can show their output on the nearest screen. Students are able to do individual or group tasks, demonstrate and discuss them in separate groups or as a whole class while displaying their output via screens. The classroom is equipped with wireless and wired Internet connection, MS Windows operating system that provides the possibility to use virtual workplaces, cloud computing services, open resources on the Internet, subscribed e-libraries and databases. The SCALE-UP classroom enables the use of various visualization, process imitation, and computer design software packages.

SCALE-UP software engineering case modeling

Outcomes of Software Engineering study subject

The course aims to introduce the object, paradigm and principles of software engineering; the conception of software engineering process, and its models; graphic design language UML, and management of software projects. The course introduces students to requirements engineering, the model of requirements process, methods of gathering requirements, analysis of requirements, specification of requirements, document templates, and assessment of requirements. Students are taught software designing, software development, testing, maintenance, and configuration management. Knowledge and abilities are reinforced with the help of provided e-course material; students do group and individual tasks.

Case model of Software Engineering study subject

The course uses MS Visual Studio environment for software designing, software development, testing, maintenance, and configuration. The studies integrate lectures and practical classes which are held according to the lecturer's plan and active learning scenario. The studies take place in the SCALE-UP classroom equipped with computerized workplaces, which enable students to use virtualization, cloud computing service, open resources, and software. Eight main topics are studied during the semester, each topic takes two weeks. Students spend three hours a week at the SCALE-UP classroom. The case model of Software Engineering lectures and practical classes at the SCALE-UP classroom (Table 1):

1. There are three stages in the course of each study topic:
    a. Introduction.
    b. Learning based on problem solving.
    c. Practical activity assisted by the lecturer.
    d. Collaborative self-study in a group.
2. Study methods: discussion, work in pairs, group work, presenting problem solutions and answering questions.
3. Evaluation methods: participation in discussions, work in pairs, group work, presenting problem solutions and answering questions.
4. Cloud computing technologies.

Table 1. Software Engineering subject: the plan of one topic of SCALE-UP active collaborative learning

Introduction	• Topic presentation	45 min	Lecture
	• Survey of information sources		
	• Summing-up		
Problem solving-based learning	• Analysis of information sources	30 min	Discussion
	• Group discussion		
	• Task discussion		
Practical activity assisted by the lecturer	• Task solution	15 min	Pair work
	• Preparing task presentation	30 min	Group work
	• Presentation	15 min	Group work
Self-study work	• Collaborative self-study work in groups		Group work

Aim, structure and tools of self-study work

The self-study work of Software Engineering course aims to help students master software engineering methods by implementing a real project. Students have to develop fully-functioning software based on the technical task and prepare the project documentation which consists of: the project plan; specification of requirements; designing document; testing plan; the system administrator and user manuals. Students are free to choose software tools to do the task. For project documentation, it is recommended to use the project management system MS Project and designing and programming system MS Visual Studio as well as a selected text editor. The documentation has to be prepared following the instructions provided by the lecturer.

Procedure of self-study work

Self-study work is performed in small groups of three members. Each group member performs individually allocated tasks and is responsible for a certain stage of the project. The project activities include six stages: project planning, drafting requirements specification, designing, programming, testing, and preparing documentation. During the first two weeks students have to divide into groups, assume responsibilities, choose the self-study task from the given list or present an idea and discuss all details with the lecturer. Students report on the completed work gradually according to the schedule (table 2).The assessment of self-study work is calculated individually for each group member, considering their roles, according to the formula (Table 3).

Table 2. Schedule of self-study work

Project stage	Presented outcome	Completion date
Project planning	Project plan	week 3
Drafting requirements specification	Requirements specification	week 5
Designing	Designing documentation	week 7
Programming	Program prototype (40% functions implemented)	week 8
Testing	Program testing plan	week 10
Programming	Running program (80% functions implemented)	week 11
Preparing documentation	System administrator and user manuals	week 12
Programming	Fully-functioning program	week 13
Preparing documentation	Self-study work report	week 14

Table 3. Self-study work assessment formula

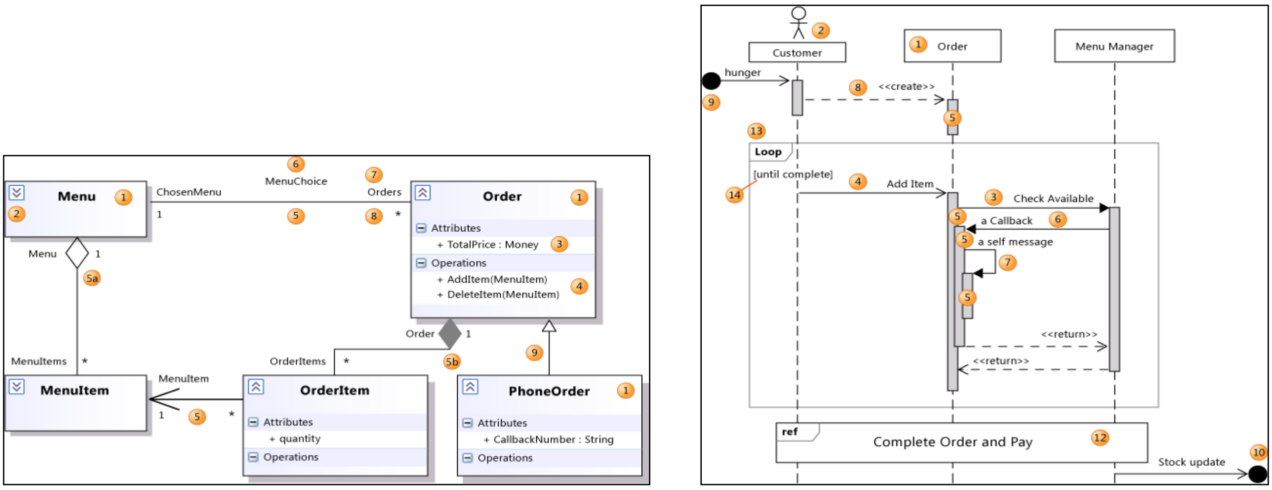
	Project leader	Analysis group leader	Designing group leader	Programming group leader	Testing group leader	Documentation preparing group leader
Project plan	0.3	0.1	0.1	0.1	0.1	0.1
Requirements specification	0.1	0.3	0.1	0.1	0.1	0.1
Designing documentation	0.1	0.1	0.3	0.1	0.1	0.1
Program	0.1	0.1	0.1	0.3	0.1	0.1
Testing plan	0.1	0.1	0.1	0.1	0.3	0.1

Administrator and user manuals	0.1	0.1	0.1	0.1	0.1	0.3
Report	0.2	0.2	0.2	0.2	0.2	0.2

Software used for Software Engineering course

The activity plan for self-study work in groups and Gantt chart are prepared using the business project management system MS Project.

Requirements specification and designing document UML schemes (Picture 2) are prepared using MS Visual Studio - the software designing and development, testing, maintenance, and configuration management system.



Picture 2. Class and Sequence diagrams

Research on the assessment of collaborative learning outcomes

The research aims to find out how students rate the Software Engineering collaborative learning outcomes and cloud computing technologies in use. This is the first part of the ongoing research on students' attitude to active collaborative learning. The research involved second and third year Software Engineering students, 84 people in total (Tables 4, 5).

Table 4. Rating of collaborative learning outcomes

Outcomes	Average rating*
Helped to find information about the main Software Engineering concepts	2,9
Improved communication skills	2,4
Improved analyzing skills	2,1
Improved ability to put into practice knowledge and skills gained during the practice	2,5
I understood the purpose and aim of Software Engineering subject	2,7
I found Software Engineering subject studies interesting	2,3
Group work experience	3

*Maximum score is 5

Table 5. Cloud computing technologies in use

Title	
Google Drive	51%
OneDrive	16%
Dropbox	5%
ICloud	7%
Other	15%
Never used	6%

The survey results revealed that students positively rate collaborative learning outcomes. When doing self-study work in groups, students prefer Google Docs, Office 365, Dropbox cloud computing technologies.

Conclusions

1. The newly-equipped class at Kaunas University of Applied Sciences meets all major requirements for SCALE-UP infrastructure and potential to implement a SCALE-UP didactic model.
2. The classroom can be used to teach different exact and technology science subjects (general and special): mathematics, physics, information technology, programming, engineering, process management and others.
3. Information technologies used in the classroom are easily integrated into the already existing e-learning infrastructure developed at Kaunas

University of Applied Sciences and create additional possibilities for active learning and setting up of the student-centered environment, as well as the development of lecturers' qualification by introducing them to the SCALE-UP didactic model and its implementation.

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