Engaging Students in Learning through Collaborative Cloud Technologies

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Abstract – **Formal education is challenged by emergent trends highlighting students' needs to develop competencies and abilities to use technologies for collaborative knowledge creation and innovation. The paper considers a case of transforming bachelor degree course towards promoting students' knowledge work competencies by using the trialogical learning approach and computer cloud technologies to increase student motivation.**

Keywords – **Knowledge work practices, Collaborative learning, Cloud technologies.**

I. Introduction

Today's students will have to tackle jobs that are profoundly different from existing ones. They will be employed in positions representing modern knowledge work in technology-rich environment. Corporations are using Web 2.0 technologies and cloud tools to allow geographically dispersed large groups of workers to collaborate. In order to manage changes in the society and in the work life, new types of competencies are needed, such as collaborative learning, networking, working in multidisciplinary teams, cultural awareness, self-leadership and flexibility.

Formal education is expected to support students in acquiring necessary competencies and in developing abilities to use technologies for collaborative knowledge creation and innovation. Prevalent pedagogical methods and practices do not usually support these new challenges because the focus is on content learning rather than on fostering higher-order knowledge work competencies. [1]. Pedagogical methods are still largely based on well-defined problems with known solutions. In results students are reported to leave higher education with underdeveloped abilities to collaborate, manage their work processes, use computers, or solve open-ended problems [2].

New strategies are needed in educational systems for introducing pedagogical models that address learning of necessary competences and abilities students to use modern computer cloud technologies for collaborative knowledge creation. Web 2.0 technologies and sites are becoming an integral part of youth culture: today's youth create, share content with other creators, and communicate via blogs, wikis and digital video. Educators can tap students' enthusiasm and creativity to shape and carry out their education agenda while preparing students for the workforce of the future. They need to find practical way to bridge conventional educational practice with new technologies in order to harness students' engagement as they address instructional objectives through creation of content.

To answer these challenges the KNORK (Promoting Knowledge Work Practices in Education) project [3] aims at developing pedagogical models and technology to support collaborative practices in technology-rich environment.

The paper considers efforts done in the Department of Electronics at the Technical University - Sofia to reconstruct pedagogical practices in compulsory course of Semiconductor devices to promote collaborative team work within computer cloud environment. The results from pilots conducted with several students group from two Faculties are also discussed.

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II. Course Redesign

A. Educational Problem

The Semiconductor device course is a basic compulsory course delivered to the huge amount of students from several faculties in 3-th semester of bachelor degree study. Before restructuring the pedagogical practices used in our teaching, we have carefully reviewed our course, its positive outcomes and drawbacks. Currently, to the students in the laboratory are given many unrelated tasks they perform in groups of 3-4 persons. Each student should individually prepare a separate report on the outcome of the practical work. Teacher guides individual student when needed.

This way of conducting training allows some students just to attend in classes without being actively involved in the tasks during the semester. Teachers cannot assess the progress of students as they evaluate the final product of their work. Since the multiple tasks are the same for all students most of them just copy the reports from their colleagues without understanding the material. Because assessment is based on individual final product, the teacher has thoroughly to conduct face-to-face examination of each student in order to evaluate him correctly.

The problem was how to restructure the Semiconductor Devices course in order to: obtain better students' knowledge and competencies, encourage better systematic training during the semester, stimulate circuit design and simulation for project verification, and transfer the initiative towards student-teacher direction. The educational challenge was haw:

- To increase the commitment and motivation of students

- To increase students' practical training, and
- To meet the requirements of business for: team work on common task, shared responsibility for the quality of the overall product; distribution of tasks in line with the specified deadline.

B. Trialogical Learning Approach

In order to meet these challenges and to resolve mentioned educational problems a new trialogical educational approach [4] was introduced with using cloud computing technologies, up-to-date communication tools for student-teacher connection, continuous monitoring and assistance students' activities.

Thrialogical approach emphasizes the organization of learner activities around shared objects that are created for some meaningful purpose or reason. This approach builds on the assumption that learning is not just individual knowledge acquisition (*monological*) or social interaction (*dialogical*), but activity is organized around transforming, or creating shared knowledge objects. A set of trialogical design principles was developed to guide the implementation of trialogical approach into pedagogical practices [5].

We decided to reconstruct the whole course giving the students opportunity to work collaboratively in group with clear role of each participant in a common work. In course redesign we have used examples and previous experiences from courses based on trialogical approach on learning [6], but in this case the problem was that the students are too many and have not enough engineering background to develop collaboratively three months long project.

Our efforts were aimed at changing the practical training to obtain better skills and competencies. Trialogical design principle was used to address:

- Team work on shared object (report)
- Continuous and prolonged work (within 2 weeks) before the laboratory work
- Strengthening the tasks of circuit design using devices' data sheets and simulation of the circuits, calculations of circuit's currents and parameters
- Continuous monitoring and teacher assistance in this process, providing help on request
- Reporting on the individual contribution of each team member to the overall project
- Respect to meet the deadline (after the prescribed date the project is locked for editing)

III. Pilots Organization

Laboratory exercises cover part of preparation and design and practical work. Team work is encouraged in collaborative development of common shared reports by using cloud computer technologies. The aim is to achieve systematic training during the semester and to stimulate design and simulation for design verification.

Instead of giving students many separate or loosely connected tasks we provide them with a large task, continuous working process, shared research plan and final presentation in groups. All group activities are organized around shared objects – collaboratively development of common project, and preparation of shared report. Project development in such practice permits for self-selected time and place allocation of the participants and teachers. Guidance is provided through systematic instructions and group work rules.

This approach permits for educational methods of direct student-educator contact that are not face-to-face, but are mediated through new communications technologies. Online communication allows students and academics to remain separated by space and time, but to sustain an ongoing dialogue.

Before the course starts are done: teams' formation; gmail accounts of all students; development of documentation templates with tasks to be done for all pre-lab project and final report; guidelines for students for practical sessions; LTspice tutorial. Students have access to learning materials in the Moodle LMS system and the Web site of the course.

Students have to prepare 8 Lab projects (4 two-week cycles with 2 lab project each) and practical measurement tasks in the semester, to pass two intermediate tests and the final exam test. The main phases in each cycle are:

- Pre-lab phase (Design & Analysis tasks – circuit design, parameter calculation, simulation)
- Face to face session (Discussion on common problems, faced by most students, answering difficult subject questions)
- Pre-lab tasks continue (Design & Analysis)
- Laboratory work (Practical measurement)
- Project finalization (final preparation of shared report including measured data)

The goal of pre-lab phase is students to be prepared in advance on devices, which they will be experimented with during the laboratory session. Teams have to develop shared reports, which include questions on device's mode of operation, basic volt-ampere characteristics, to design simple circuits with basic device applications and to calculate device parameters. A number of problems are assigned to be investigated using simulation tools. During this activities student use schematic capture & graphic drawing, simulation of characteristics to explore influence of different parameters (temperature, currents or voltages), calculation of device parameters, circuit design - currents, resistance, parameters, design verification by simulation.

Face-to-face session is intended for discussion of common problems, faced by many students.

During the lab measurements students perform practical work in the laboratory measuring devices in different mode of operation, different temperatures and signal frequencies. All measured data are filled in shared document by using students' smartphone or computers.

In project finalization phase students have to prepare final shared report including measured data, drawing graph on these data and parameters calculation. Reports also include conclusions, answering problem questions, concerning device application, which are not covered in the practical sessions.

Students' knowledge is evaluated continuously during the semester and by final exam test. The shared report grade is based on next criteria: material/organization, presentation, depth of material, handling of questions, solving problems and conclusion on simulation and measurement results. Commenting activities and communications between students - teachers (emails, participation in discussions, pear comments) are also appreciated.

IV. Collaborative Workspace Environment

The used environment consists of public cloud based services, combined in a way that supports collaborative electronic design reports development (see Figure 1). All participants had to register individual Google accounts. The teacher was responsible for creating a Google Docs document for each project report and sharing it with the team.

During the course we use cloud & communication tools and specific tool for simulation. Google Tools are used for collaborative development of a common shared object in the cloud – Google Drive, Google Docs, Sheets; Google calendar – to set deadlines and to monitor progress – assignments, intermediate stages reporting, deadline for submission of project.

Students work in teams of 2-3 persons and are required collaboratively to design, analyze and measure circuits with basic semiconductor devices. During the semester every team needs to prepare within fixed deadline 8 (two week long) reports, concerning features and characteristics of different semiconductor devices.

Completed document on the long-term group work is created in Google Drive as a shared document with the possibility of collaboration between the team members and comments from the teacher. In the shared space it is possible to upload files Word documents, graphics, pictures and other materials as well as measured data during practical exercised in the labs (there is Wi-Fi in the classroom and students are allowed to use their laptops or smartphones to access shared report).

As a Specific tools for analysis phase is used LTspice® – Free Circuit Simulation, Schematic Capture and Waveform Viewer Tool http://www.linear.com/designtools/software/.

Students were encouraged to ask for help or advice, via email, at any time and not to wait for the scheduled classes. For student–teacher communications are used Google applications: Gmail, Calendar, Drive и Google+. Usually they were getting a response during the same day. Announcements were made on a Google+ hangout and via email. Each class had a Google calendar with all relevant milestones and class schedules. For inter team communications students can choose their preferred tools (chat, conferences, e-mail, forum).

V. Results

The pilots were conducted with 6 students group during autumn semester of bachelor degree courses in Electronics and Computer Systems and Technologies.

In order to describe their opinion and experience of the course students are asked to answer through SurveyMonkey https://www.surveymonkey.com/ to the following open questions: How would you characterize your overall experience in the course? What has been positive or impressive in the course? What has been challenging or disturbing in the course?

For the students this was their first course in which they work in team and they consider this very positive, challenging and useful to understand the benefits of working in collaboration. Most students appreciated the fact that they had to work in a group and share the work between the members by using technology.

The students appreciated the visibility of their contributions to the common work. They said that they have understood how important is the expertise and commitment of others when developing common products. They also noticed that during team work they started knowing their colleagues better contacts and even make new friends.

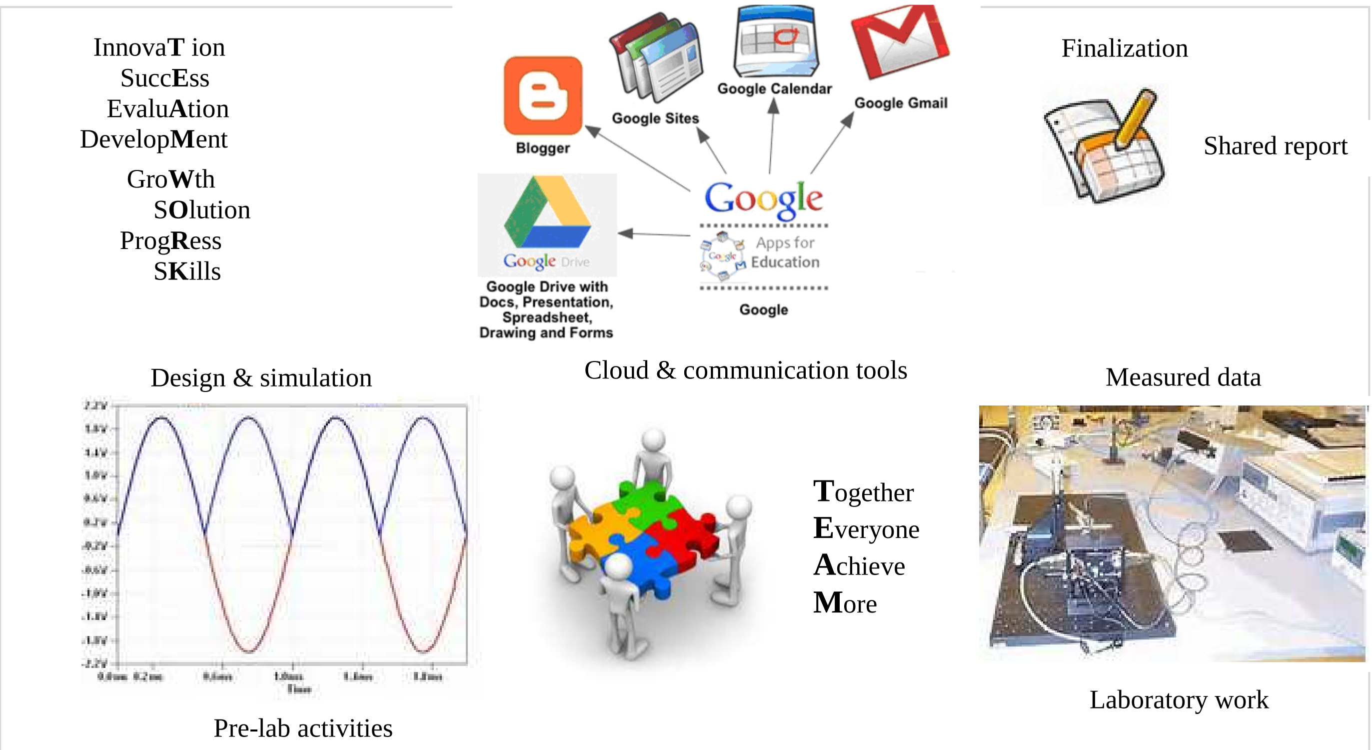

Fig. 1. Collaborative workspace structure

Innovative way of working in teams using up-to-date digital technologies was appreciated. The positive aspects identified from students are mainly related to the possibility to know and learn new tools, to study in an innovative and engaging way, to have immediacy support from teachers by receiving timely feedback and help. The immediacy of the help provided via email, compared to the scheduled face to face meeting, was cited as a major plus in the post-course surveys. Being able to receive a timely advice on their design problems was highly regarded. They consider positively the opportunity to work at any time at any place, which helps them to manage their free time in more effective way. Some students complain that part of the team does not work well and do not contribute to the quality of common work. Most of the students are satisfied with the new way of course delivering and declares that their expectations were exceeded.

Teachers adopted new pedagogical practices compared to previous courses: longitudinal work which also supported students' more in-depth focusing, students' collaboration for a shared outcome. According to teachers, the students learned knowledge work practices, such as information processing, analysis, presentation and sharing, longitudinal work, using digital tools and group work in general. The teachers felt that it is important that the new practices were successfully used for improving obligatory courses and for a large group of students. All teachers will continue to apply the practices and this course and into their other courses.

VI. Conclusion

The paper considers transforming bachelor degree course towards promoting students' knowledge work competencies by using the trialogical learning approach and computer cloud technologies to increase student motivation.

Introducing new technologies and paradigms in established engineering courses is always challenging. In addition to the core subject matter, students had to learn new tools and development workflows. In a whole, it has been a rewarding experience for both students and teachers. As positive results could be mentioned:

- Greater interest and involvement of the majority of students.
- Besides their knowledge on the subject students acquire skills to work in a team and to use advanced tools for collaboration and communication in the network.
- Better preparation for laboratory work – students are acquainted with the problems, with devices' mode of operation and the characteristics, which they will explore
- Avoiding the problem of copying reports from one to other and their delivery to the end of the semester (the project is locked after the deadline).
- Control of the process and the contribution of each participant – notes and comments of the teacher in total shared reports during its development in the Google docs' document.

As problems students mention difficulties in distribution work between team members, insufficient opportunity to learn from their mistakes and those of their colleagues, lack of habit to comply with fixed deadlines for projects' submission (after the final date the project is locked for editing).

As a problems teachers reported:

- Difficulties in precise evaluation of personal contribution of each team member to common work
- Problems how to force lazy students to work well
- Extremely heavy-duty of assistants not only in classes but also in the preparation of assignments for individual & shared work and continuous consultations, monitoring and evaluation of many students' reports.

Based on upper mentioned outcomes we will try to improve the solution in next course release by dividing role between students in the team and to rotate these roles during the semester, by rewarding and punishing student by bonus points, contributing to their final score, by forcing the students to comment on each other's work throughout the course. We will try to reduce teaching load by giving students less number but bigger reports (which will be more easy to be monitored) and by minimizing face to face seminars through development of guides how students to use cloud tools.

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