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Cloud Computing in Collaborative Learning in Electronics

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Abstract – **The paper considers introduction of new pedagogical practices in engineering education to answer requirements of 21st century. It discusses restructuring of Semiconductor Devices course to establish team work on shared reports. Leveraging the cloud to create a self-paced, learner-centered environment is described. Using the new collaborative practices and activities to ensure an enjoyable implementation experience during the pilot course is emphasized. Results from conducted pilots are highlighted. Advantages of cloud collaborative technologies for deeper learning are also commented.**

Keywords – **Cloud Computing, Collaborative Learning, Electronics Education**

I. Introduction

Our world is changing at an unprecedented pace. Skills like critical thinking, communication, collaboration and creativity will be essential for students to take on the challenges and opportunities that lie ahead. In today's world, information and knowledge are increasing at such an astronomical rate that no one can learn everything about every subject, and the jobs that students will get after they graduate may not yet exist.

The revolutionary development of the technology allows access to information in the real world anywhere, at any time. This is even more pronounced for young people who have grown up with technology as an integral and ever-present part of their lives. Today's students are natural investigators, researchers and synthesizers of information. Using technologies in which students are already well versed is a powerful way to support independent, enquiry-based learning and collaboration [1].

Cloud computing environment promotes education with a dynamic content and course delivery. It provides highly scalable and elastic services to end users to exploit technology computing benefits for active learning. These collaborative tools are also very useful for teachers, but the role of the teacher need to change [2].

Universities need to adapt and develop new ways of teaching and learning that reflect a changing world. The purpose of education should be to prepare students for success after graduation. For this reason, students need to be taught how to process, parse, and use information, and they need adaptable skills which they can apply in all areas of life [3].

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To answer these challenges we aim at developing pedagogical practices that support collaborative learning in technology-rich environment. The paper discusses efforts done and the experience in restructuring pedagogical practices that offers collaborative learning in the cloud at the Department of Electronics in the Technical University of Sofia. A case study of applying "trialogical" approach to learning in Semiconductor Devices course and the use of cloud computer technologies to support collaborative learning is reported.

II. The Educational Problems and Challenges

The arrival and rapid dissemination of digital technology in the last decades of the 20th century creates a big discontinuity between generations. Today's students are no longer the people our educational system was designed to teach [4]. Loads of information is coming to them via the Internet and everything they do is through the screen: writing, the learning, the reading, downloading and listening to music, designing and even communicating with the world. As a result of this ubiquitous environment and the interactions with it, today's students think and process information fundamentally differently from their predecessors. They are used to receiving information really fast. They like to parallel process and multi-task, and function best when networked.

The problem is that today educational system is designed by assumption that learners are the same as they have always been, and that the same teaching methods will work as before. But this is no longer valid. Our students have changed radically [4]. When teaching them sequentially, steps by steps, giving the same tasks as others students, forcing to write individually the same reports as others, they very fast lose interest and motivation to learn, start rewriting reports from others just to sign for the semester.

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. 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.

Realizing that the students are quite different from before it's high time to change our view on education. We need to reconsider both the methodology and pedagogical approaches. The human element is a critical component of the educational process. For educators learning new ways to do old stuff is a very hard task.

For the Semiconductor Devices course the educational challenge was to increase the commitment and motivation of students and to meet the requirements of business for:

- Better practical training;
- Team work on common task;
- Shared responsibility for the quality of the overall product;
- Distribution of tasks in line with the specified deadline.

The problem was how to restructure the Semiconductor Devices course in order to:

- Achieve systematic training during the semester,
- Acquire improved students' knowledge and competencies
- Stimulate circuit design and using simulation for project verification,
- Transfer the initiative towards student - teacher direction

III. Course Restructuring

In order to achieve these objectives and resolve problems a new trialogical educational approach [5] was introduced with using cloud computing technologies, up-to-date communication tools for student-teacher connection, continuous monitoring and assistance students' activities.

The problem was how to re-design our course to better promote students' knowledge work competencies and how to implement the trialogical design principles [6] in own teaching. It was inappropriate to use previous experience in conducting collaborative project based learning [7] since these students at their 3rd semester of study haven't any engineering background. We decided to reconstruct the whole course and to adapt design principles as summarized in Table 1 in order to give students opportunity to work collaboratively in group with clear role of each participant.

Trialogical approach 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)

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.

Table 1. Implementing the Trialogical Design Principles

Design Principle	Implementation in own teaching
DP1: Organizing activities around shared objects	Collaboratively development and preparation of shared reports. Students choose team partners according their interests and preliminary experience.
DP2: Supporting integration of personal & collective agency and work	Motivate students to manage tasks distribution between team members by giving students' responsibility to be team leader in turn. Combining participants' own interests in shared reports through assessment process – the quality of the reports and the responsibilities to deadlines are evaluated with better grade.
DP3: Emphasizing development and creativity through knowledge transformations and reflection	Support flexible use of various kinds of knowledge: theoretical, literary sources; practical examples and cases; pictures, interactive training tools; Make students comment on each other's work throughout the semester, having opponent groups who comment on each other's first drafts not only final report.
DP4: Fostering long-term processes of knowledge advancement	Continuous working process – two week pre-lab design & analysis phase, performing several simulation of explored device characteristics, design circuit using this device and calculate circuit and device parameters. Planning and start writing the documents, sharing the drafts, getting feedback from the teacher, improving the report, using forums and blogs for discussing problems and exchanging views and opinions.
DP5: Promoting cross-fertilization of knowledge practices and artifacts across communities	Students use up-to-date cloud computing and communication tools in order to plan, perform, and organize and wright shared reports. Students and teachers collaborate on solving a shared problem.
DP6: Providing flexible tools for developing artifacts and practices	*Google Drive, Docs, Sheets* – for collaborative editing, reviewing and commenting *Google calendar* – to set deadlines and to monitor progress – assignments, intermediate stages reporting, deadline for final report submission *Google applications*: *Gmail, Calendar, Drive u Google+* for student – teacher communications For in-team communications students can choose their preferred tools (chat, conferences, e-mail, forums)

IV. Course Organization

Our efforts were aimed at changing the practical training to obtain better skills and competencies. Students work collaboratively in teams of 2-3 persons on shared common report, which is continuously monitored, taking into account the individual contribution of each team member.

Preliminary work performed before starting the laboratory sessions consists of: teams' formation, creating Gmail accounts of all students, development of templates with tasks to be done for all pre-lab projects and final reports, preparing guidelines for practical laboratory tasks.

Practical training is organized in two-week cycles with the main phases in each cycle as shown in Fig.1.

The 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.

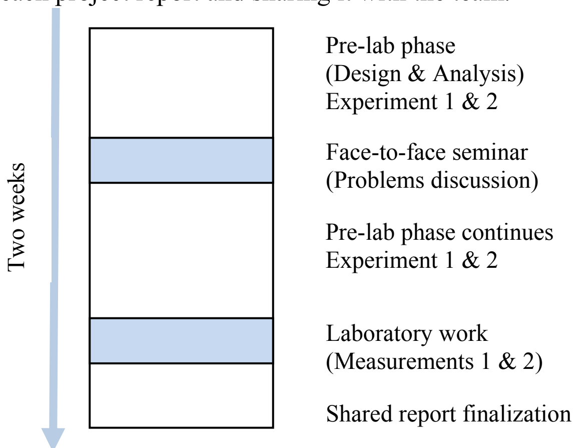

Fig. 1. The main phases of two week work cycle

The goal of pre-lab phase is students to be prepared in advance on device features, which they will explore during the laboratory session. Team need to develop shared report, which includes theoretical and practical topics. Activities during this phase involve schematic capture, graphic drawing, calculation of device parameters, circuit design as well as design verification by simulation.

Intermediate seminar session is predicted for discussion of common problems and difficult subject questions, faced by most students as well as problems with cloud tools used. Activities include questions, answers, slides and computer presentations, and explanation how to use ICT tools.

In the laboratory session students perform practical work with measurement instruments to explore particular devices in different mode of operation, various temperature conditions and signal frequencies. All measured data are filled in directly in shared document by using students' smartphone or computers. There is Wi-Fi in the classroom and students are allowed to access the shared report.

Finalization of shared report includes graph drawing from measured data, parameter calculations, answering problem questions, making conclusions etc.

Students' knowledge is evaluated continuously during the semester and by final exam test. The shared report grade is based on next criteria: material organization, depth of material presentation, handling of questions, resolving problems and clear conclusions on simulation results and measured data. Commenting activities and communications between students and teachers are also appreciated.

V. Cloud Environment

A significant part of the work is done outside regular class (design and analysis, consultations on projects, discussions, teachers' commenting during design phase, in team communications etc.). The environment consists of public cloud based services, combined in a way that supports team work for collaborative development of shared reports (see Fig. 2).

Google Drive, Docs, Sheets are used for collaborative development of a common shared object in the cloud; Google calendar – to set deadlines and progress monitoring (assignments, intermediate stages reporting, deadline for submission of final project).

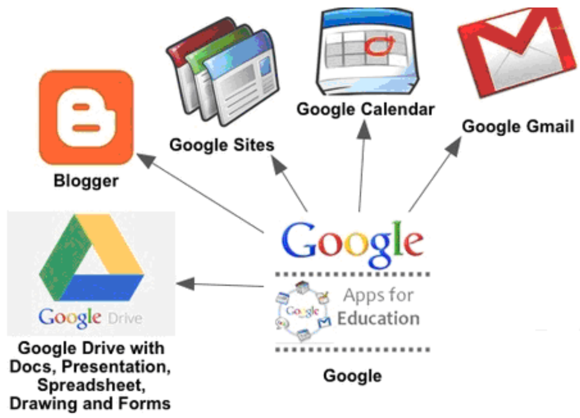

Fig. 2. Collaborative cloud tools used

All participants had to register individual Google accounts. 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 the teacher. In the shared report can be uploaded files, Word documents, graphics, pictures, waveforms from simulation, measured data from lab exercises and others.
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/.

For inter team communications students can choose their preferred tools (chat, conferences, e-mail, forums). For student–teacher communications are used Google applications: Gmail, Calendar, Drive и Google+.

VI. Result from Pilots

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 and collaborative work students are asked to answer through SurveyMonkey https://www.surveymonkey.com/ to several statements before and after the course and also to 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?

The students' (N=97) answers to the seven statements before and after the course, concerning their ability to work collaboratively in group, are shown in Fig. 3.

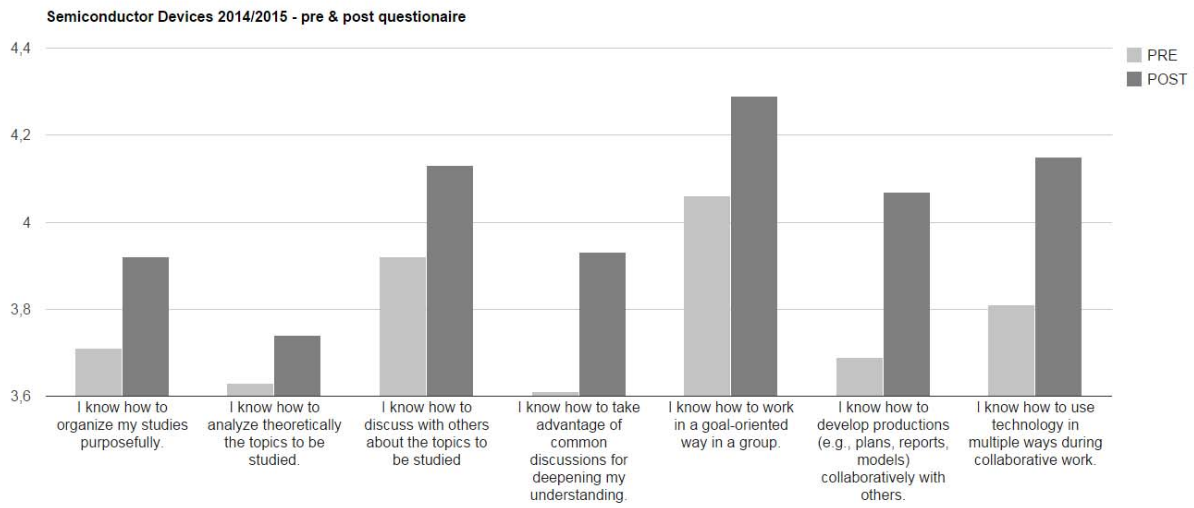

Fig.3. Average of the students' answers concerning the seven statements at the beginning and at the end of the course in Semiconductor Devices

Students consider their first experience to work in teams as very positive, challenging and useful to understand the benefits of collaborative working. Most of them are satisfied with the new way of course delivering and declares that their expectations were exceeded. Innovative way of working in teams using up-to-date cloud computer technologies was appreciated. The positive aspects identified from students are mainly related to the possibility to use and learn new tools, to study in an innovative and engaging way, to have immediate support from teachers by receiving timely feedback and help. The opportunity to work at any time at any place is reported as an advantage, which helps them to manage their free time in more effective way. Students commented that have understood how important is the expertise and commitment of others in development of common products. They also noticed that during team work they started knowing their colleagues better than before, which helps in improving their everyday social contacts and even make new friends.

Some students reports for difficulties in distribution work between team members, for insufficient opportunity to learn from their own mistakes and those of their colleagues and lack of habit to comply with fixed deadlines for projects' submission since after the deadline, the project is locked for editing.

VII. CONCLUSION

The paper considers the problems faced in education of engineering disciplines and an attempt to resolve part of them by introducing new educational practices promoting collaborative learning in bachelor degree course. The "trialogical approach" of learning is applied to the compulsory course on Semiconductor devices in order to introduce team work on shared common report. The benefits of collaborative learning include:

- Development self-management and leadership skills.
- Promotion of active student-teacher interaction.
- Increase in student responsibility.
- Critical thinking and problem solving
- Exposure to diverse perspectives
- Collaboration across networks
- Accessing and analyzing information
- Preparation for real life social and employment situations.

The drawbacks include difficulties in precise evaluation of personal contribution of each team member and inability to force lazy students to actively contribute to the common work. Based on upper mentioned outcomes we will try to improve the next course release by dividing role between students in the team and rotating these roles during the semester and forcing them to comment each other's work.

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