Knowledge Process Learning with the Linguistic Structures

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ABSTRACT: *We in this paper address the collaborative learning process in the secondary schools. We studied the trialogical process and understand the knowledge learning using two case studies. The design we have used and the network technologies we have deployed are studied extensively. Ultimately, the knowledge process learning with the linguistic structures is studied.*

Keywords: Collaborative Learning, Knowledge Work Practices, Computer Cloud Technologies

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1. Introduction

In an increasingly global economy, effective creation, use and dissemination of knowledge is the key to success. In order to manage changes in the society and in the work life, new types of competencies are needed, such as collaborative learning, cultural awareness, self-leadership and flexibility. Widespread 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]. Many educational analysts and industry representatives report that students leave higher education with underdeveloped abilities to collaborate, manage their work processes, use computers, or solve open-ended problems [2]. Current technology now offers many more possibilities for sharing, archiving, retrieving, combining and generating new knowledge. Particularly in secondary education, technology is used infrequently, only by some teachers and often for previously established teaching methods but not for transforming practices.

Rapid changes and demands of the knowledge society, acceleration of technology and networking challenge educational institutions to reconsider pedagogical practices to ensure that students acquire necessary future competencies during upper secondary and university education. New strategies are needed for introducing pedagogical models addressing the use of collaborative work and cloud information technology into the educational systems. Students need interdisciplinary, goal-oriented projects, where cross fertilization between schools, higher education institutions and professional organizations is enabled.

The paper discusses efforts done at the Department of Electronics of the Technical University of Sofia (TU-Sofia) and the Technology School Electronic Systems, associated with the TU-Sofia to reconstruct pedagogical practices to promote necessary competences. Two case studies of applying trialogical learning approach [3] for university and secondary school education are discussed. The results from pilots conducted in the ASIC Design and Networking Technologies courses are also highlighted.

2. Courses Reconstruction

In order to promote the development of new competencies through education, specific design principles based on the trialogical approach were created for supporting the design of pedagogy [4].

The problem was how to re-design our courses to better promote student knowledge work competencies and how to implement the trialogical design principles in own teaching in order to increase motivation of students to learn, to enhance their professional competences and soft skills:

- Abilities to resolve complex problems;

- Better practical training (experience in using professional software and CAD tools);

- Working on multidisciplinary tasks, utilizing multiple knowledge sources;

- Abilities to work in group;

- Abilities to use modern computer technologies and environments;

- Networking.

In order to achieve these objectives and resolve problems a trialogical educational approach was introduced with using cloud computing technologies, up-to-date communication tools for student-teacher connection, continuous monitoring and assistance student's activities. We decided to reconstruct the courses and to adapt design principles as summarized below:

DP1: Organizing activities around shared object - Collaborative development of a semester long project and, preparation of a shared report.

- **Activities:** face to face meeting for the distribution of project tasks, defining and preliminary review of the tools used; getting students acquainted with the phases of the design cycle.

- **Team Organization:** students are free to choose team partners.

DP2: Supporting integration of personal and collective agency and work t

- **Coordinate the participants interest -** Team members to choose an appropriate project they want to develop and are interested in.

• Motivate students to manage tasks distribution between team members, having respect to deadlines by giving each student the responsibility of being a team leader in turn. There are two strictly defined deadlines during the project cycle and performing tasks within given deadlines is one of the criteria for project evaluation.

• Combining participants' own interests and shared project through assessment - process the quality of the shared project and the responsibilities concerning deadlines are evaluated with a higher grade.

DP3: Emphasizing development and creativity through knowledge transformations and reflection

• Support versatile use of various kinds of knowledge: theoretical or literary sources; practical examples and cases; pictures, models. Discuss problems student faced during collective work on the shared object.

• Reflect on collective practices and knowledge.

• Make students comment on each other's work through the semester

• Encourage students to independently and creatively initiate, lead and manage a development process.

• Require student to apply already obtained knowledge and skills in using professional CAD tools to resolve complex practical tasks.

DP4: Fostering long-term processes of knowledge advancement

• Continuous working process, iterative design process to improve circuit and system performance in order to fulfill technical specifications.

• Planning and start writing the documents, sharing the drafts, getting feedback from the teacher and other students, improving the project and project report, submitting relevant documents.

• The best final team projects and their shared reports are used during the course as good examples for other teams, as well as after the course by the students themselves or by others.

DP5: Promoting cross-fertilization of knowledge practices and artifacts across communities

• Students use professional tools for projects development. They are provided with professional work models and design flow cycle used in the software and electronic industry.

• Expert practices are modelled for students, via templates and tools.

• Students and teachers collaborate on solving a shared problem.

• Students use up-to-date cloud computing and communication tools for planning, organizing and writing shared reports.

DP6: Providing flexible tools for developing artifacts and practices

• Google Drive for collaborative authoring of the project reports, reviewing and commenting.

• Google calendar - to set deadlines and to monitor progress - assignments, intermediate stages reporting, deadline for submission of the project.

• For inter-team communications students can choose their preferred tools (chat, conferences, e-mail, forums).

• For student teacher communications Google applications are used: Gmail, Calendar, Drive.

Applying these design principles during the last two years, several engineering courses were re-designed at the TU - Sofia and the Technology school “Electronic Systems” from traditional face-to-face to collaborative project oriented adopting and applying modern online learning platforms, cloud collaboration tools, and social software. In the next section are discussed two cases in which teachers promote students’ knowledge work competences at university and secondary school education.

3. Asic Design Course

The bachelor degree ASIC Design course was transformed to project oriented following trialogical design principles in order to give students opportunity to work collaboratively in group with clear role of each participant. The infrastructure for collaborative learning consists of public cloud-based services, combined in a way that supports electronic design workflow (Figure 1).

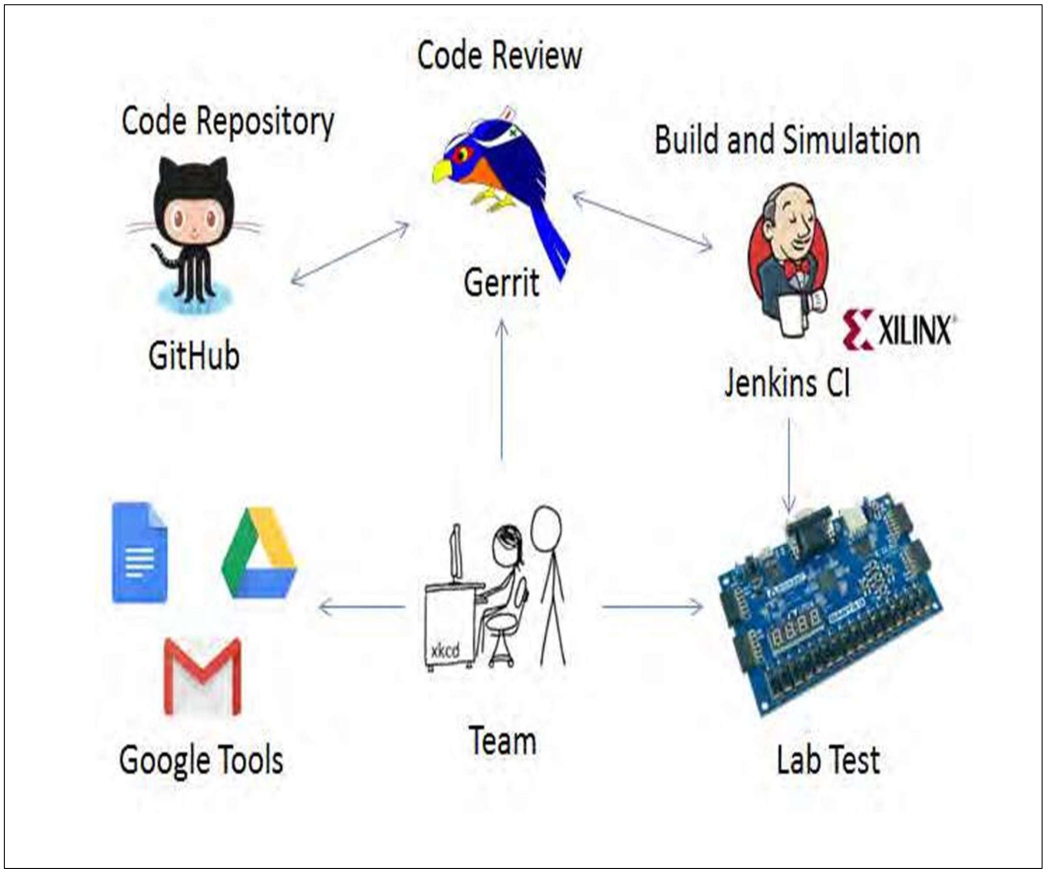

Figure 1. Collaborative workspace

Working in small teams, the students are required to design a digital Application Specific Integrated Circuit (ASIC). The design workflow is based on HDL (Hardware Design Language) modelling, verification and synthesis. The main design artefacts (HDL models and test-benches) are text files; therefore, we are able to borrow many tools and workflows from the software development community. Projects are hosted on GitHub [5] one repository per project.

In parallel with the code development, the teams are required to create and maintain a Google Docs document which is one of the major deliverables. Initially the document contains the technical specifications of the design. Later on, the students have to add description of the implemented algorithms and architectures, argumentation of the trade-offs made and the results from the simulation, synthesis and physical design.

Most of development takes place outside the regular classes. For their intra-team communication, the students are free to choose whatever tools they prefer (chat, conferencing, email). For student - teacher communications we decided to

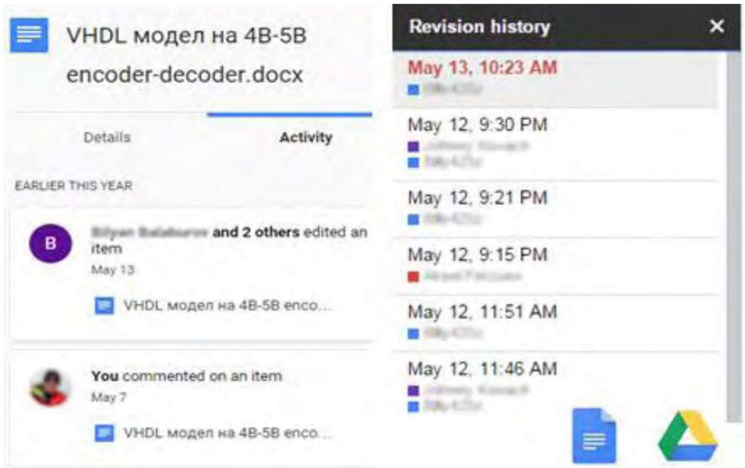

Figure 2. Collaborative artefact evolution Google Docs/Drive

use the Google tools. Students were encouraged to submit their questions as in-document comment or email.

Collective artefacts evolution is followed through GitHub Revision History and Google Docs Revision History (Figure 2). GitHub is optimized for hosting software projects. It provides a very detailed history of commits for each repository. In the majority of cases, the tools provided by GitHub are more than adequate for analyzing the evolution of the students' projects.

The functionality offered by Google Docs with respect to exploring documents history is rather limited. At a file level, there is an activity view, that provides a good overview of when and who created or modified a particular document. At document level, we have a Revision history, which shows a timeline of the changes, but no information about the scope of each change.

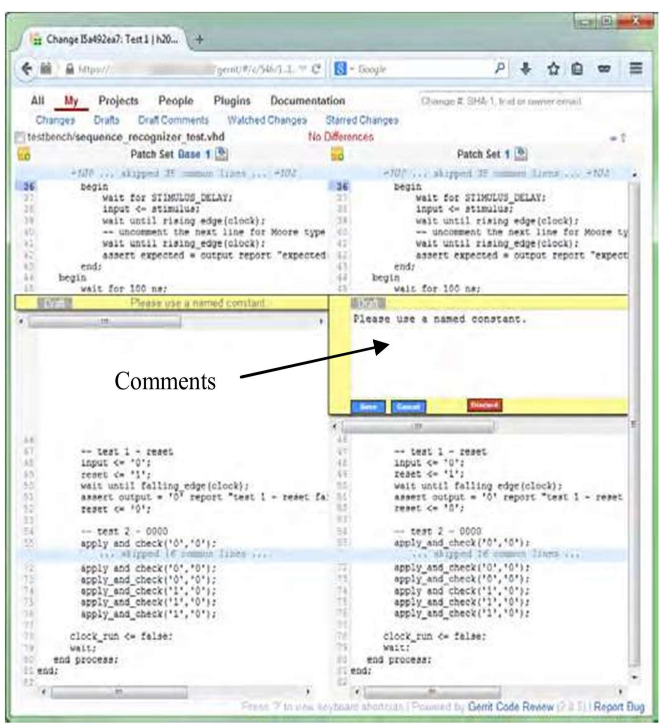

Figure 3. Peer review

An effort is made to follow the test-driven development process - first crate a test-bench then the model that makes all the tests pass. Students are aware that the comprehensive test coverage will be one of the primary project evaluation and scoring criteria. All tests-benches should be self-checking - i.e. no "manual evaluation" of the simulation results should be required to determine the correctness of the model. Team members have a collaborator right for the respective repositories, but they were asked not to commit directly. Each change had to be peer reviewed before it can be committed to the project repository. When a team member submits a change for code review, the project is automatically built and the tests are executed. Another team member shall perform a code review and either approve the change or return it to the submitter for rework. System allows the reviewer to attach comments to a source code file or a particular line inside the file (Figure 3).

The pilots were conducted with fourth year bachelor students. Each team had to choose a project subject from a list provided by the teacher. Two project milestones were set intermediate report and final report. Each class had a Google calendar with all relevant milestones and class schedules. Project development in such practice permits for self-selected time and place allocation of the participants and teachers.

4. Global Networks Course

This case is an example of introducing university type of education in secondary school. Instead of giving 12th grade students many separate or loosely connected tasks strictly developed by the teacher we provide them with 31 weeks long project. All group activities are organized around shared objects collaboratively development of common project, preparation of shared report, continuous working process, and final presentation in teams. Secondary school students have to perform collaborative network design (Fig.4). In addition to the collaborative project work, they were required to submit several individual homework assignments.

Guidance is provided through systematic instructions and group work rules. Assessment includes process and product assessments, and contribution evaluation of each participant to the collaborative project development.

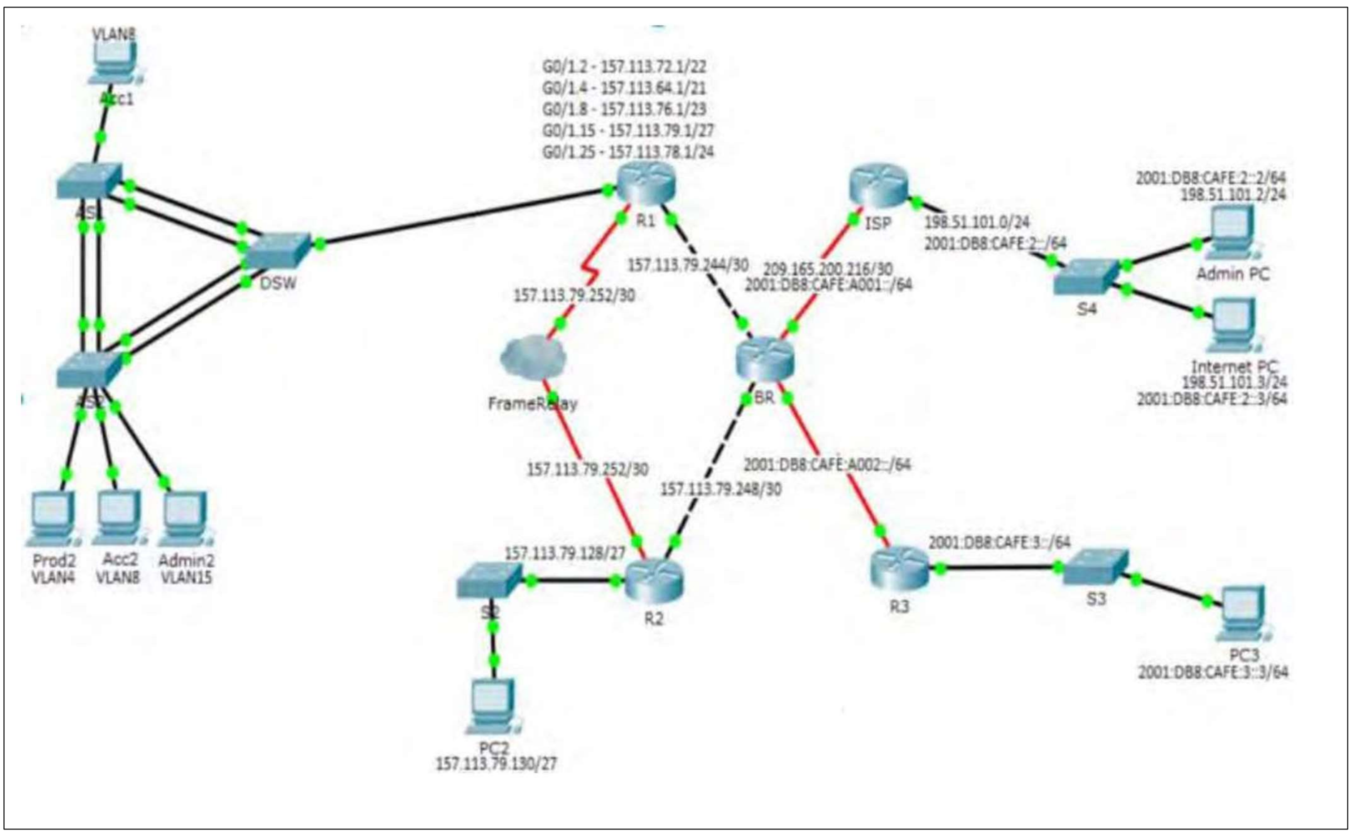

Figure 4. Collaborative network design

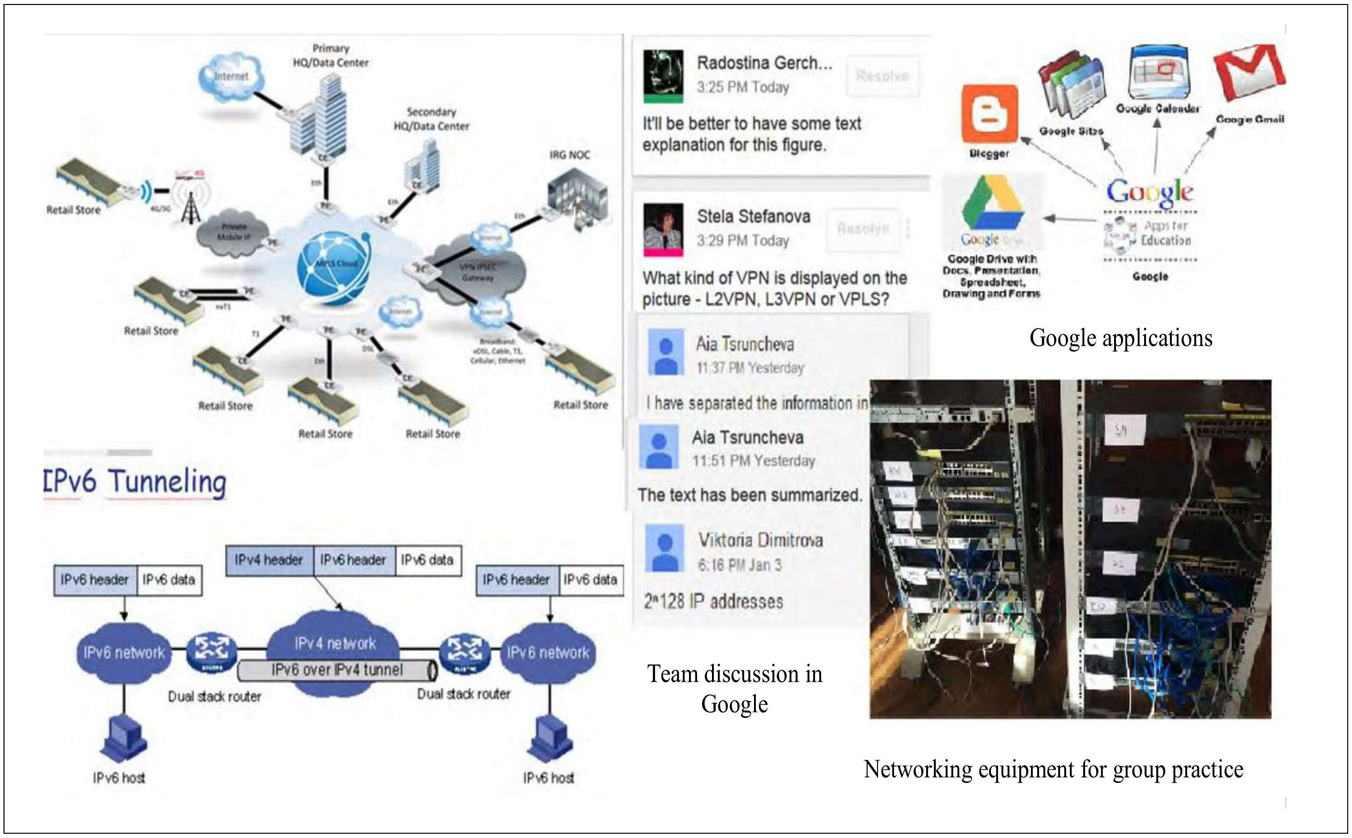

Figure 5. Collaborative workspace for network design

Collaborative workspace for network design is shown in Figure 5. Successful project development requires continues working process with iterative network configuration, performing numerous analysis of the designed network to refine the network parameters and characteristics, planning and writing the documentation, sharing the drafts, asking the teacher and other students for feedback, improving the project and project documentation, submitting respective report and presenting the obtained design and simulation results. All these require intensive use of modern communication tools - forums, blogs and social media for discussing problems.

Students submit their questions as in-document comment, which are context related. Professor answers in the document. The discussion is part of the artefact (Figure 5).

Students are advised by specialists from the ICT industry. Industry professionals, teachers and students discuss and analyze collaborative experience. Already gained knowledge and skills are practiced in the laboratory to solve the tasks of the project by using dedicated networking equipment.

5. Conclusion

The paper considers two case studies for introduction of collaborative learning approach at university and secondary school education to promote knowledge work competencies by implementing the trialogical design principle. The courses were re-designed from traditional face-to-face to collaborative project-oriented adopting and applying modern online learning plat-forms, cloud collaboration tools, and social software.

Activities and environments used in the conducted pilots are discussed. In a whole, it has been a rewarding experience for both students and teachers. The trialogical approach was well accepted and considered as an appropriate path for collaborative activities. Students consider their experience to work in teams as very positive, challenging and useful to understand the benefits of collaborative working. Together with learning subject matter they played (and learned) with new communication and collaborative technologies. The immediacy of the help provided via email and in-document, contextual comments, compared to the scheduled face to face meeting, was cited as a major plus in the post-courses surveys in both institutions university and technology school.

Acknowledgement

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References

[1] Muukkonen, H., Lakkala, M., Kaistinen, J., Nyman, G. (2010). *Creating Inquiry in a Distributed Project Research and Practice in Technology- Enhanced Learning*, no. 5, 73- 96.

[2] Commission on Accountability in Higher Education, Accountability for better results: A national imperative for higher education, Boulder, CO: State Higher Education Executive Officers, 2005.

[3] Paavola, S., Lipponen, L., Hakkarainen, K. (2004). *Models of Innovative Knowledge Communities and Three Metaphors of Learning Review of Educational Research*, 74 (4) 557-576.

[4] Paavola, S., Lakkala, M., Muukkonen, H., Kosonen, K. (2011). *The Roles and Uses of Design Principles for Developing the Trialogical Approach on Research in Learning Technology*, 19 (3) 233-246.

[5] GitHub, https://github.com/