

# Application of Trialogical Design Principles to Practical Education in Networking Technologies

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**Abstract** – This paper discusses a course re-design to promote new pedagogical practices applying a trialogical approach. The results from pilot course in Global Networks Education of 12 grade classes in Technology School “Electronic Systems” associated with Technical University of Sofia are demonstrated.

**Keywords** – collaborative learning, knowledge practices, knowledge work competences

## I. INTRODUCTION

The Partnership for 21st Century Learning (P21) [1] has developed a vision for student success in the new global economy.

To help practitioners integrate skills into the teaching of core academic subjects, P21 has developed a unified, collective vision for learning known as the Framework for 21st Century Learning [2]. This Framework describes the skills, knowledge and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise and literacies.

Every 21st century skills implementation requires the development of core academic subject knowledge and understanding among all students. Those who can think critically and communicate effectively must build on a base of core academic subject knowledge.

Within the context of content knowledge instruction, students must also learn the essential skills for success in today’s world, such as critical thinking, problem solving, communication and collaboration.

When a school or district builds on this foundation, combining the entire Framework with the necessary support systems - standards, assessments, curriculum and instruction, professional development and learning environments - students are more engaged in the learning process and graduate better prepared to thrive in today’s global economy.

The graphic shown in Fig. 1 represents each element distinctly for descriptive purposes, the Partnership views all the components as fully interconnected in the process of 21st century teaching and learning [2].

### A. Key Subjects and 21st Century Themes

Mastery of key subjects and 21st century themes is essential to student success. Key subjects include English, reading or language arts, world languages, arts, mathematics, economics, science, geography, history, government and civics.

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In addition, schools must promote an understanding of academic content at much higher levels by weaving 21st century interdisciplinary themes into core subjects:

- Global Awareness;
- Financial, Economic, Business and Entrepreneurial Literacy;
- Civic Literacy;
- Health Literacy;
- Environmental Literacy.

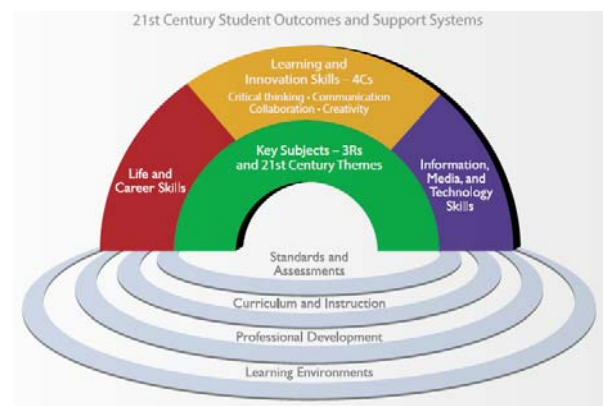


Fig. 1. Components of 21st Century Teaching and learning

### *Learning and Innovation Skills*

Learning and innovation skills are what separate students who are prepared for increasingly complex life and work environments in today’s world and those who are not. They include:

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration

### *Information, Media and Technology Skills*

Today, we live in a technology and media-driven environment, marked by access to an abundance of information, rapid changes in technology tools and the ability to collaborate and make individual contributions on an unprecedented scale. Effective citizens and workers must be able to exhibit a range of functional and critical thinking skills, such as:

- Information Literacy;
- Media Literacy;
- Information, Communications and Technology (ICT) Literacy.

### *Life and Career Skills*

Today’s life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills, such as:

- Flexibility and Adaptability;

- Initiative and Self-Direction;
- Social and Cross-Cultural Skills;
- Productivity and Accountability;
- Leadership and Responsibility.

Developing a comprehensive framework for 21st century learning requires more than identifying specific skills, content knowledge, expertise and literacies. An innovative support system must be created to help students master the multi-dimensional abilities that will be required of them. The Partnership has identified five critical support systems to ensure student mastery of 21st century skills [2]:

- 21st Century Standards;
- Assessments of 21st Century Skills;
- 21st Century Curriculum and Instruction;
- 21st Century Professional Development;
- 21st Century Learning Environments.

#### B. Key features of 21st Century Pedagogy

The key features of 21st century pedagogy are [3]:

- building technological, information and media fluencies;
- developing thinking skills;
- making use of project based learning;
- using problem solving as a teaching tool;
- using 21<sup>st</sup> century assessment with timely, appropriate and detailed feedback and reflection;
- It is collaborative in nature and uses enabling and empowering technologies;
- It fosters Contextual learning bridging the disciplines and curriculum areas.

To answer these challenges the KNORK (Promoting Knowledge Work Practices in Education) project [4] aims at developing pedagogical models and technology to support collaborative practices in technology-rich environment. KNORK is a 3 year, EU-funded integrated project with 9 partners from 4 countries. The partners represent the synergies between high education institutions and secondary schools in each country.

The paper discusses efforts done in the Technology School "Electronic Systems" associated with the Technical University of Sofia to reconstruct a course and pedagogical practices applying a triological approach in Global Networks education. The results from pilot course in Global Networks education in 12 grade classes are highlighted.

## II. TRIOLOGICAL APPROACH

Present-day students will be employed in positions representing modern knowledge work. These involve abilities of group work, collaborative learning, networking, working in multidisciplinary and multicultural teams, complex problems, and dealing with uncertainty and confusion. This requires new pedagogical practices to be developed to promote necessary competences. Triological approach to learning [5] is one possible solution to these challenges.

*Triological 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 (see Fig. 2). While the acquisition and

participation approaches provide valuable resources, respectively, for understanding individual and social aspects of learning, these metaphors do not appear to provide tools for understanding deliberate processes of advancing and creating knowledge typical of knowledge-intensive work in the present age. The *trialogical* approach is intended to elicit innovative practices of working with knowledge within educational community [5].

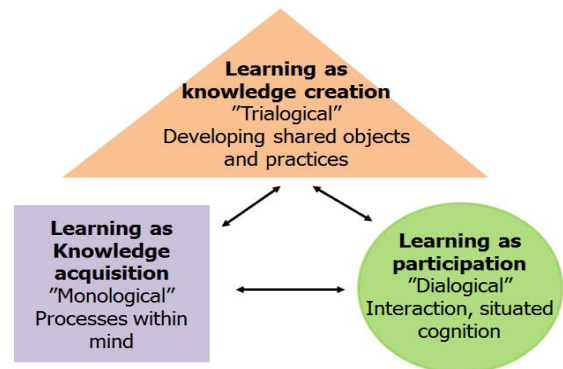


Fig. 2. Three metaphors of learning

## III. COURSE DESCRIPTION AND COURSE PLAN

A specialized course in the field of Global Networks, giving the students opportunity to obtain:

- Practical knowledge in networking;
- Ability to use up-to-date professional tools, services and equipment to design networks;
- Skills in teamwork;
- Knowledge in how to manage their work in terms of tasks and time distribution for fulfilling deadlines;
- Ability to present and report their work, considering the problems they face and how they are resolved, or why these problems cannot be resolved.

The practical training of the students in the Global Networks course consists in two major projects during the term, which are made on weekly basis.

The Course Plan has the following main aspects:

*Pedagogical context* - The students should have passed the specialized courses Local Networks, Informatics, Information technologies from the previous school years.

*Previous achievements* - The course is taught during the first term of the fifth year and students are expected to use the knowledge, they have obtained previously, for the project.

*Prerequisites* - Local Networks, Information technologies.

*Objectives* - The course is designed to give the student an understanding of the different design steps and tools required to carry out operating network.

*Knowledge and understanding*

- Explain and understand networking basics;
- Explain and understand operation of switches, routers, wireless controllers, access points and firewalls;
- Apply the theoretical knowledge to a project.

*Skills and ability* - After finishing the course students should have abilities to:

- Use modern professional tools for network design and implementation;
- Work efficiently as a group;
- Manage their work in terms of tasks and time distribution for achieving deadlines;
- Present and report their work considering the problems they face;
- Hold and evaluate, discuss and justify the proposed solutions;
- Make peer reviews and comment results.

*ICT tool(s)* - Networking equipment such as routers, switches, cables, etc. Google Doc, Google Application, Google Drive, Google Sites.

*Preparations before the course* - Find potential projects. Prepare the platform (Google Apps): create folders for the groups, the workspaces, upload learning material, allocate projects themes according the groups, create project development agenda.

#### IV. COURSE RE-DESIGN

We re-design our course to ensure possibilities for collaborative work of student teams on common shared tasks. The dialogical design principles, described in section II, are used in the process of course re-organization. The implementation of the principles of dialogical approach can be summarized in following way:

*DP1: Organising activities around shared objects*

- Teams organization - students will have the ability to choose their teams by yourself.
- Collaborative development of common project, and preparation of shared;
- Task distribution between the members of a team;
- Activities: regular meetings for discussion of project tasks and preliminary review of the used tools and the progress of the project development.

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

- Coordinating participants – team members will choose the partners they want to work with;
- Motivating students to distribute tasks between team members take the responsibility for the project deadline;
- Collective responsibility - in the group each member takes the responsibility for their project tasks.

*DP3: Emphasizing development and creativity through knowledge transformations and reflection*

- Discussion and analysis of problems the teams faced during their collective work on the common project;
- Thoughtfully and creatively establish, conduct and operate the project development;
- Practice already gained knowledge and skills in using dedicated networking equipment to solve the tasks of the project.

*DP4: Fostering long-term processes of knowledge advancement*

- Prolonged working process with iterative network configuration – performing number of 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;

- Using forums, blogs and social media for discussing problems and talk about their points of view and opinions.

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

Students contribute with specialists from the ICT industry. Industry professionals, teachers and students discuss and analyze collaborative experience. Students use modern professional tools in order to plan, organize, and execute the project tasks and write project documentation.

*DP6: Providing flexible tools for developing artifacts and practices*

Students use the tools for collaborative work:

- Google Docs for collaborative editing and commenting; Google Drive for file sharing; Google+ for discussions;
- Project management – Google Apps;
- Google Calendar - very useful for project scheduling - related events by sending RSVP invitations;
- Google Sites – for designing of course site;
- Face to face and virtual meetings – Skype.

#### V. COURSE ORGANIZATION

The Global Networks course in the Technology School “Electronic Systems” is re-designed to be project oriented. Working in teams of 2 persons, the students are required to performing number of analysis of the designed network to refine the network parameters and characteristics. During the long term projects teams have to gather information, discuss the given problem in collaborative environment, analyze and troubleshoot the network topology applying pre-defined networking technologies and protocols. The students have to document their work at every step of the development process and to upload in Google Drive project space. In the end of the two or three weeks long projects students will have to present their presentations for the given topics. The students will have weekly assignments, developed collaboratively-shared presentations in the field of Global networks. These homework activities are presented, discussed and analyzed in class.

The assessment is based on the written project report and the discussion with the project team. The evaluation criteria are: fulfillment of design goal according given technical specifications, quality of the design solution, meeting the deadlines for submission of intermediate and final reports, quality of the written reports.

#### VI. COLLABORATIVE LEARNING PLATFORM

During the long term projects and weekly assignments on the subject of Global Networks students have to gather information, discuss the given problem in collaborative environment, collect the needed information, analyze the topics for the presentations. Most of developments take 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 decide to use the Google tools (see Fig. 3): Groups, Gmail, Docs, Talk, Calendar, Drive and Google+. Students were encouraged to submit their questions as emails instead of chat messages.

The students will have to document their work at every step of the development process of long term projects and weekly assignments. They have to create, edit and comment the collaborative documents in the different Google Drive Spaces.



Fig. 3. Collaborative workspace structure

These homework activities are presented, discussed and analyzed in the class and uploaded in Google Site of the Global Networks Course (See Fig. 4., and Fig. 5.).

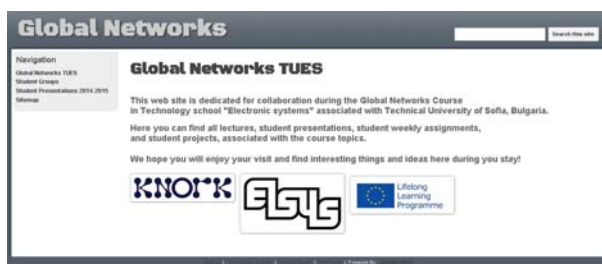


Fig. 4. Home Page of Google Site of Global Networks Course

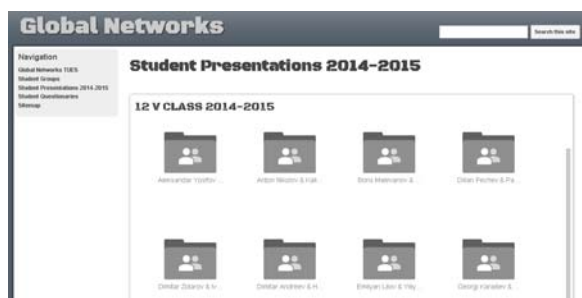


Fig. 5. Students Projects in Global Networks Course

## VII. RESULTS FROM PILOT COURSE

The pilot course is conducted with one class of 29 students – 12 grade class (31 weeks). Each team had to choose a project subject from a list provided by the teacher. In addition to the project work, students were required to submit several homework assignments.

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.

We manage to transform course from classical face to face teaching to using project based approach in order to motivate student and increase students motivation, their knowledge work competences and digital skills. The main results and experiences can be generalized as follows: 1) Students work in a collaborative environment with shared documents; 2) Experience in the use of modern cloud technology; 3) Experience in the rearrangement of the course content; 4) Creation of a web-based Global Networks course platform.

In the beginning of the course a pre-survey was done through Survey Monkey. A questionnaire was sent to the students in order to find out more about their background and study skills. After the course the post-questionnaire is done to evaluate students' self-reflections concerning knowledge work practices related to their experiences in the implemented Global Networks course and to observe their progress. The students were asked several questions: 1) I know how to organize my studies purposefully; 2) I know how to analyze theoretically the topics to be studied; 3) I know how to discuss with others about the topics to be studied; 4) I know how to take advantage of common discussions for deepening my understanding; 5) I know how to work in a goal-oriented way in a group; 6) I know how to develop productions (e.g., plans, reports, models) collaboratively with others; 7) I know how to use technology in multiple ways during collaborative work.

The 29 students' answers to the seven statements after the course are reported in Fig. 6 together with their answers to the statements before the course.

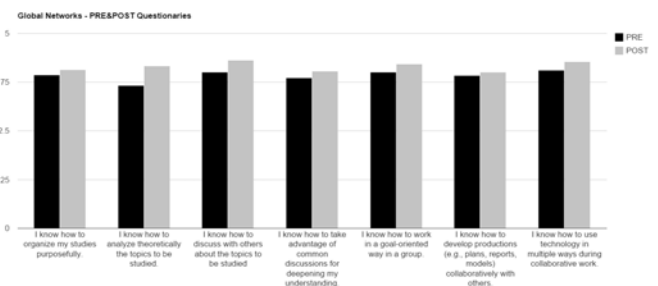


Fig. 6. Average of the students' answers

## VIII. CONCLUSION

The paper discusses a course redesign to promote new pedagogical practices, which were successfully used for improving obligatory course Global Networks in secondary education.

Pilots' results are focused on students' collaboration for shared outcomes. Students learned knowledge work practices - information analysis and presentation, sharing, commenting, using digital tools and team work. We need to find ways to promote even further the collaboration between the students and monitor their group and individual progress. The Global Networks course has room for improvement in the following directions: 1) Optimal distribution of students in groups - not only according to their desire; 2) Criteria for evaluation of responsibilities in teams, according to the complexity of the project; 3) Update the criteria for the assessment of current tasks and

defining the severity of these criteria in forming the final course grade of the individual team members.

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