ABOUT THE PROBLEM – ORIENTED APPROACH IN HARDWARE AND SOFTWARE ENGINEERING EDUCATION

Mila Radoslavova Neykova, Ljudmila Rumenova Taneva

Technology School "Electronic Systems", Technical University, Sofia, Bulgaria,
phone:+35928751094, e-mail: mnejkova@hotmail.com lusy_t@yahoo.com

Keywords: problem-oriented approach, problem-based learning, project-oriented education, programmed education, group work.

The paper "About the problem-oriented approach in hardware and software engineering education" discusses the problem-oriented approach and its application in teaching computers at high school. The development of information technologies has significant influence over the educational area. Considerable changes in teaching approaches are required, to satisfy the information society needs. It is necessary to combine different methods depending on educational goals. Problem-oriented instruction in hardware engineering is suitable especially in teaching sophisticated themes as microprocessor systems and microcontrolers and takes place mainly in laboratory practice. The problem-oriented educational approach in software begins with simple programs writing and develops into large and sophisticated programs, written individually or by students' groups. This paper presents the development of a concrete project - computer aided instruction programs "Dynamic Data Structures", created by groups of students. The project-oriented education results show high motivation increase, activity and creative work stimulation and definitely – higher level of students' knowledge.

1. INTRODUCTION

The rapid growth of information technologies (IT) brings about greater potentials and possibilities in using technologies as a powerful medium in improving the instruction process. Compelling change of skills needed at workplace drives education communities in all over the world to re-think about education requirements and processes. These factors lead to transformations in education methods and pose new challenges to educators in acquiring skills and competencies not only in technology literacy but also in pedagogy.

The teaching methodology in computers is an important factor in uniting students' theoretical knowledge with its practical application in solving problems. The complex nature of treated educational themes requires combining different methods depending on educational goals level. Traditional educational methods as lectures and discussions combine with problem-based learning (PBL), project-oriented education (POE) and e-learning, in order to improve the knowledge quality, to increase motivation and to prepare students to meet technologies progress challenges and to cope with sophisticated problems in IT area.

The main objectives of our research are to discuss the nature of the problem-oriented approach, to find its place and relations with other educational methods and forms, to present its application in software and hardware engineering education at high school, and to confirm the need of expanding its role in teaching computers.

2. THE PROBLEM – ORIENTED APPROACH AND ITS RELATION WITH OTHER EDUCATIONAL METHODS

The problem-oriented approach is a set of educational activities, such as organizing problem situations, problems formulating, helping student in solving problems, solutions control and evaluation. There are 5 levels of this approach (fig.1). There are no problem situations in information statement and students cognitive activity is very low. This activity grows up from level 1 to 5. Since 1st and 2nd levels could be realized by lectures and discussions, 3rd, 4th and 5th levels require using different ways and forms of problem-oriented approach.

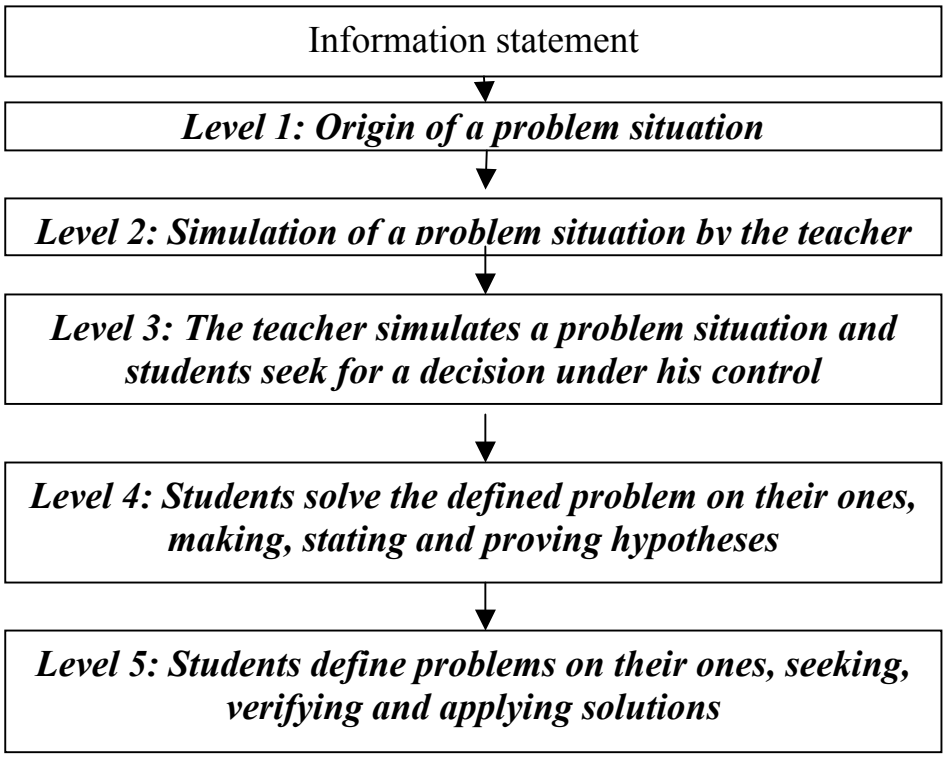


Figure 1

Regarding students cognitive activity, we could graduate educational methods as:

lectures and discussions -> problem-based learning –> project-oriented education.

Project-oriented education (POE) is related to problem-based learning (PBL). Both educational models aim at active learning, but there are differences. In PBL groups work in presence of a tutor. Tasks are rather small. Lectures are important. The result is knowledge. In POE groups work mostly without a tutor. Tasks are realistic and big. Group work is product oriented. Results are knowledge and skills. Task division is often used. Students are centered in the project work. [1]. Important point in applying PBL and POE is creating appropriate problems and the valid assessment of the students learning. PBL and POE differ from traditional instruction, and therefore student knowledge and achievement may be better measured with alternate assessment methods as written and practical examinations, peer and self-assessment, teacher assessment, oral and written reports [2]. Applying PBL and POE requires combining group and individual work. Important points in organizing group

work are the group size (usually 3 - 6) and distribution of responsibilities. When a group is working harmoniously, students learn a lot of science; when it is not, they learn a great deal about themselves and strategies for coping with conflict [3].

Specific characteristics of hardware and software education allow using the benefits of e-learning. E-learning could be defined as any technologically mediated learning using computers whether from a distance or face to face. It includes Web-based and computer-based learning, delivery of content via all electronic media as Internet, intranets, satellite, broadcast, video and CD-Rom [4].

There is a link between problem-oriented approach and so-called programmed education, or education driven by goals. The main idea is that as a first step educational goals are defined. Next, the teacher creates a set of problems. Solving these problems by students guarantee that the goals are achieved. The 3rd step is to determine information students need to know to solve the problems (fig.2).

Figure 2

A classification of the educational goals, known as Bloom's taxonomy, determines six categories in cognitive domain [5]:

1. Knowledge. Remembering of appropriate, previously learned information.
2. Comprehension: Understanding the meaning of informational materials.
3. Application: Use of previously learned information to solve problems.
4. Analysis: Breaking informational materials into their component parts, examining the structure, developping conclusions by identifying motives or causes.
5. Synthesis: Creatively applying knowledge and skills to produce a new whole.
6. Evaluation: Judging the value of material based on personal values/opinions.

Different levels of competence require different educational strategies and approaches. Since the lectures method is suitable for achieving goals from lower levels as knowledge and comprehension, the problem-oriented approach helps reaching objectives at higher levels as application, analysis, synthesis and evaluation.

The complex nature of problem-oriented approach and its relationships with other educational methods, forms and principles are shown in fig.3.

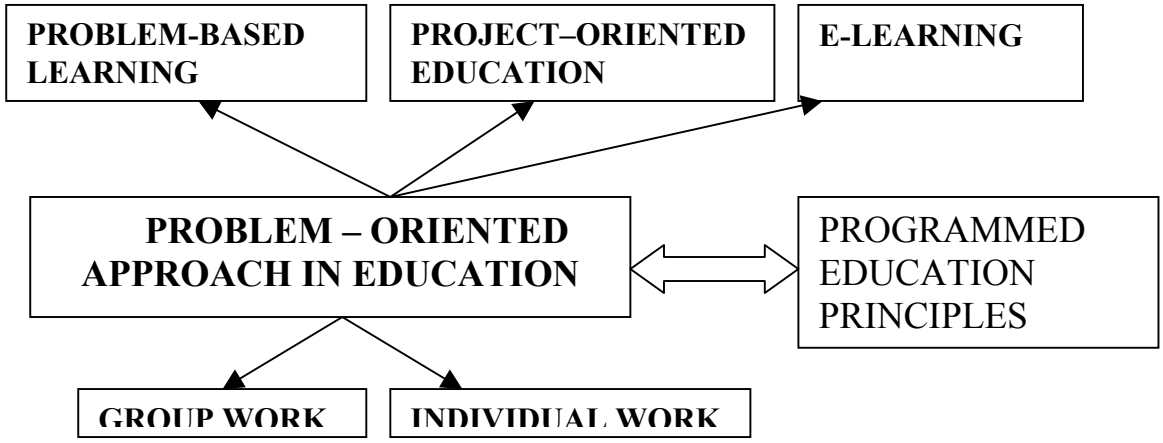


Figure 3

3. APPLICATION OF THE PROBLEM – ORIENTED APPROACH IN HARDWARE AND SOFTWARE SUBJECTS EDUCATION

Problem-oriented approach in Microcontrolers (MCU) teaching could be realized by a system of laboratory practice and individual/group students work. In basis of the laboratory practice lays the science research (fig.4). There is analogy between problem-oriented approach and science research, in spite of the difference in their objectives. The starting point for both processes is the problem situation.

Design of the lectures and the laboratory practice requires hardware and software platform where the MCU is not only an educational tool. The MCU with its on-chip resources is the research system. Selecting the right MCU for education is not an easy decision, as MCUs have been more complex devices since on-chip resources were added. The MCU education includes a theoretical knowledge of MCU and learning some useful function of subsystems under control of MCU. Teachers have been teaching with lectures and lab exercises, but the border between them is not so clear now. The educational process has to combine the traditional principles of education with POE, e-learning, interactive methods and alternate assessment methods.

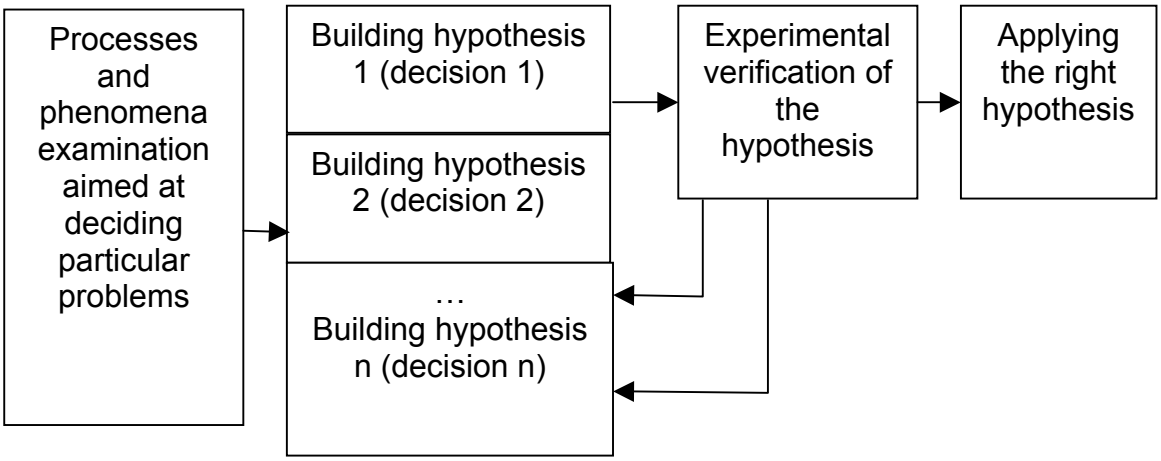
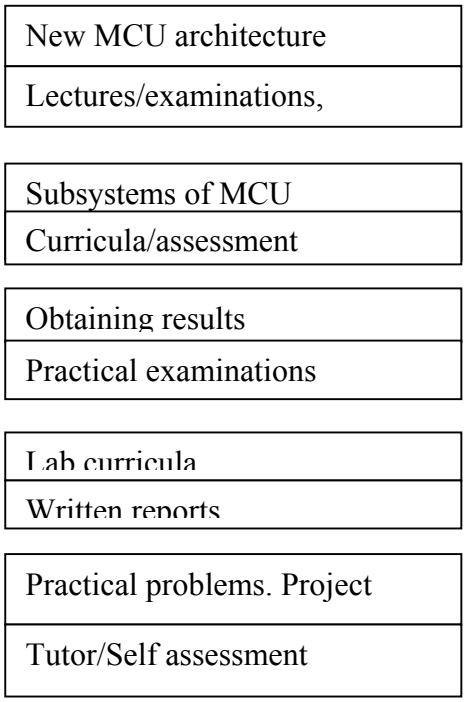


Figure 4

Educational course on MCU at our school - TU ES aims at active learning and includes five levels (fig.5). Teaching MCU begins with lectures about a new architecture of MP/MCU. Then it continues with introduction of development environment and software, lab exercises, research the architecture, practical examinations, making simple programs in assembler to control different subsystems, results assessment. The main purpose of the course is to provide students with knowledge and practice, which engages them in thinking about solutions of real problems. The course covers multiple hardware platforms, programming techniques and development tools. The software platform and e-learning applications make possible network transfer of skills and knowledge, network exchange of programs, simulation and training programs, distance learning and collaboration.



Level 1 Verbal information – level of teacher/classroom interaction, provide information that must be included in the E-learning environment.

Level 2 The level of the learning interaction between learner and computer

Level 3 The level of assessment – teacher/self control or by modules of the software.

Level 4 POL – Small group works in presence of a teacher. Task are realistic and cover most of the subject matter of the curriculum.

Level 5 POE – Small group or one student works without the presence of a tutor. Tasks are big and cover a small part of the subject matter of the curriculum. This level includes e-learning also.

Figure 5

The problem-oriented approach in software education begins with simple programs writing and develops into large and sophisticated programs, written individually or by students' groups. This paper presents the development of a project – a computer aided instruction (CAI) program "Dynamic Data Structures". It is a menu driven program with a hierarchical structure, following the structure of the theme (linear (stack, queue, list) and non-linear (trees, graphs) structures) – fig.6.

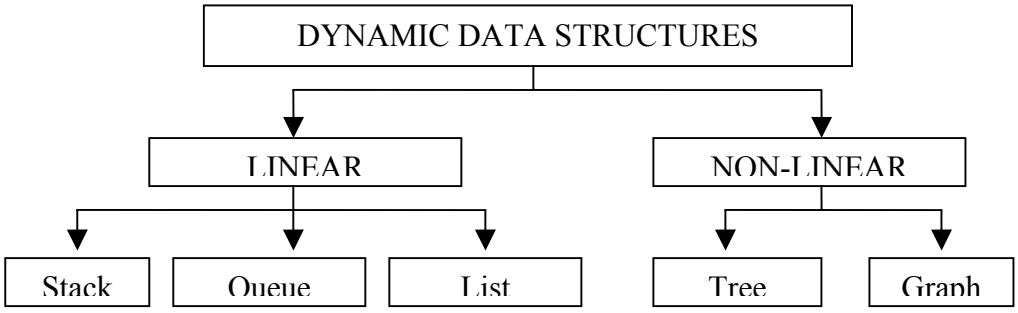


Figure 6

Teaching "Dynamic Data Structures" (DDS) theme begins with lectures and writing C programs to realize data structures and basic operators and to use these structures in solving applied problems. This way we cover educational goals levels as knowledge (students define DDS, their structure and operators), comprehension (classify DDS; explain the differences between them; give examples) and partly - application (develop programs using DDS; solve applied problems; implement physically DDS; report results).

The project "Dynamic Data structure" aims at covering higher educational objectives levels as application, analysis and evaluation.

Main stages of the project development are: defining goals, students responsibilities and deadlines (by teacher at class); development of the CAI program by students groups with periodical reports about development stage, problems and results; presentation and evaluation of the final results.

We used mainly group and individual work at home, and the work in class was limited only to determine tasks and responsibilities and to report and summarize results. Groups of students worked on two variants of the project – web-based system and console application, written in C programming language. There were 8 to 16 students in each group. The work in every team simulated a small software firm – there were project managers and persons responsible for different branches and sub themes. During the project development students came across series of problems – professional, social and psychological. Students had to study new technologies and skills (to design web sites, to use animation and graphics) and new products (Macromedia Dreamweaver, Flash). They had to integrate different activities as C programming, searching information, working with graphics, creating presentations (every group had to make Power Point presentation of their product).

Project achievements could be assumed in different aspects. We got a useful product - CAI program to be used in future courses in DDS. We also covered a number of pedagogical goals – higher students creativity and activity in solving complex problems; skills for working in groups; higher levels of covered educational goals as application, analysis, synthesis and evaluation (exploring variants for creating menus in graphical mode, evaluating and choosing the most appropriate one; analyzing, evaluating and applying methods for physical realization of DDS).

4. CONCLUSIONS

Practical results show that the problem-oriented approach in hardware and software engineering education gives students an opportunity to apply theoretical competence in real applications and an experience that cannot be learned in classical lectures. It also gives social interaction, cooperation to obtain results, and use of new multimedia technologies and the Internet.

The created CAI programs are a step in applying e-learning in software education at our school. These programs could be a starting point for a future electronic textbook – written by students and intended for students. This textbook could be improved and expanded with new themes by next students generations.

The project development results show high motivation increase, activity and creative work stimulation and definitely – higher level of students' knowledge.

5. REFERENCES

[1] http://edweb.sdsu.edu/clrit/PBL_WebQuest.html

[2] http://www.coun.uvic.ca/learn/program/hndouts/Studygr.html

[3] Wilkerson L., *Identification of skills for the problem-based tutor: Student and faculty perspectives,* Annual Meeting of the American Educational Research Ass., San Francisco, CA,1992

[4] www.learnframe.com/aboutelearning/glossary.asp

[5] Anderson L., D. Krathwohl, *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, New York: Longman, 2001.