Project Based Learning in ASIC Design

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Abstract: The paper describes EC Leonardo Netpro II project activities, concerning network based project learning in engineering education. Restructuring, organization, results and problems faced in a pilot project based course in ASIC Design, delivered at the Technical University of Sofia are discussed. Difficulties in organizing international teams from students working in the same subject are also mentioned.

1. Introduction

Important question in designing every course is how to organize teaching process so that learners find exactly the sequence of experience that lets them accomplish their learning goals. What learning approach to choose, how to structure and deliver material so that each learner follows a unique learning path, what skills must be performed, how to motivate student to self-organizing learning process, which allow them to transfer obtained knowledge to useful in practice design are important topics especially in structuring engineering subjects.

Project Based Learning (PLB) is a teaching and learning strategy that engages students in complex activities. It is a model for classroom activity that shifts away from short, isolated, teacher-centered lessons [1,2]. Instead project based learning

- Emphasizes learning activities that are long-term and student-centered
- Addresses real world issues and practices
- Provides opportunity for interdisciplinary learning
- Involve students in problem-solving and decision-making
- Promote collaborative design in cooperative group learning
- Allows students to work autonomously to construct their own learning and
- Culminates in realistic, student-generated products.

One immediate benefit of practicing PBL is the unique way that it can motivate student [3] by engaging them in their own learning addressing real world concerns, and developing real-world skills. Instructors no longer actively create and direct exercises for passive student, but instead just guide student ideas. Responsibility, realism, active learning, and feedback are among the important features of PBL. In addition to encouraging successful learning many of the skills learned through PBL are those desired by today's employer, including ability to work well with others, make thoughtful decisions, take initiative, and solve complex problems.

To achieve these pedagogical goals and to face industry requirements to the workforce, the ASIC Design course was restructured to incorporate PBL approach. The paper considers the course planning, organization, results, advantages and problems met in a pilot PBL course in ASIC Design, delivered at the Technical University of Sofia.

2. Planning Project Based Learning in ASIC Design

Project-based learning requires a higher degree of planning and organization. Several key factors was considered in course planning [4]

- Curriculum issues

The goal is student to learn core curriculum as they work on the project. Successful integration of content learning requires projects to have clearly stated goals and to support and demonstrate content learning both in process and product. The objective, which students follow should be supported by project activities, so that the final project to answer the standards defined in the curriculum.

- Time Frame & Materials to support deep understanding and engagement

A good project extends over a significant period of time. The problem is how to organize the time frame in order to provide each student adequate time for: equal opportunity to participate; interpretation of content, effective collaboration and project development; access to quality subject-matter recourses and professional tools for simulation and chip specialization, time for design process, completion of complex tasks and assessment.

- Collaboration

This component is intended to give students opportunities to learn collaboration skills. Collaboration may take different forms: students' partnership, team projects, cross-group or cross-university projects. It is important how the curriculum should be structured to accommodate and promote for each student role, contributions, and opportunities to collaborate and make decisions.

- Student Direction

Student direction is a key element of the model. The question is what is relation between given framework, established by the teacher and what decisions are left up to the students. We try to provide opportunities and support for each student to define a project in own terms with a relation to course content; to design effective project documentation & presentation and to engage them in real-world research practices as well as in self- and peer-assessment. The amount and nature of student decision-making depends on students' motivation.

- Real-World Connection

The PBL seeks to connect student projects with the real life. Connection to the worksite problems can be established by content chosen, activities type, product types, and professional design tools used. It is important to arrange opportunities for each student to develop real world practices of communication with a purpose; collaboration/ teamwork, project management, effective use of feedback.

- Assessment

It is important to evaluate student knowledge and competences as a result of project work. Adequate assessment should be captured based on clearly defined standards; student reflection and revision.

Taking in consideration above mentioned factors for successful PBL planning we reconstruct existing traditional ASIC Design Course delivered at the Technical University of Sofia to incorporate projects as a main tool for effective learning.

3. Organization of PBL in ASIC Design Course

To face challenges of PBL approach the existing ASIC Design course was restructured and organized in three main parts: lectures, practical sessions and project development. Assessment also plays an important role in this restructuring.

Lectures are intended to cover course material. It includes ASIC types, design methodology, basics of VHDL, synthesis, Xilinx FPGAs and PLDs architecture, design flow and design automation tools. All lecture slides are published on a Web server and are available anytime to anyone. Instead of classical material explanations lectures are organised as a discussion on main topics. Different problems are considered – what technology to choose, features and performance of different architectures, how to select appropriate chip for design implementation, which criterions are important, what are advantages or disadvantages of given decision, comparison between different solutions etc.

Practical sessions are intended student to become familiar with methodology and design automation tools before starting to develop projects. These sessions are based on tasks that students should complete alone by using guided materials published on the university server. For each skill or concept, the learner has the opportunity to see an example or to practice applying it. In practical sessions students obtain hands-on experience with VHDL simulator Model Sim XE and Xilinx ISE 5 tool. Students obtain help on request.

Project development is performed as teamwork without guidance. This is a main part of the project base learning pilot course. It is organized in a manner to maximize student decision-making and initiative through the project development – from team building and topic selection to design, production and presentation decisions. Students are encouraged to explore various topics. They have freedom to propose project topic of their interest, to choose different strategies and approaches for implementation. Projects are connected to real profession through use of authentic methods, practices and professional tools. Real world connection also is made by communicating with the world outside the classroom, via Internet or collaboration with students from other university. The underlying principle is that learning occurs during these unstructured, complex activities. Working on actual, close to real-world tasks, they become more engaged in the learning process and produce realistic products. Students enjoy learning when they feel that learning makes sense.

Projects challenge students and motivate them. They acquire communication, planning, collaboration, decision-making, problem solving, and self-evaluation skills. Student have online access to reference materials and data sheets on university server, as well as use Internet connection to find every think they need over the Web. On request students obtain support from the teachers.

Project tasks include specification, VHDL description and simulation, synthesis to appropriate Xilinx PLD or FPGA chip, place and route, real chip configuration and testing. Project report has to explain circuit functionality, VHDL code, result

of simulation, synthesis output and chip configuration file. Some example topics of student projects developed within pilot PBL course in ASIC Design are [5]:

VHDL Model of a Microprocessor
PIC micro controller (PIC16Cxxx)
MP3 player
Seven segment driver with I2C interface
Home security system
Electrical power meter control unit
USB controller
Graphics LCD Driver
Home heating system control
Serially Interfaced, 8-Digit Asynchronous LED Display Driver

Students use online resources to create research reports and to publish project deliverables on a Web server in html format. Most of the students create attractive Web pages for project documentation and project presentations.

Assessment. With its innovative approach to learning, PBL also requires an innovative approach to assessment. Project based learning requires teacher assessment as well as peer assessment, self-assessment and reflection. Self-evaluation is encouraged. It gives students a sense of achievement and further responsibility and control over their learning. Students who are involved in the project assignment gain valuable experience in setting their own goals and standards of excellence. By documenting students' decisions, integrating peer feedback, revisions, teachers and students can capture valuable material for assessing student work and progress. Assessment practice should also be well understood by students. Clear evaluation criteria were stated before starting project development. Project complexity, professional skills, (teacher responsibility) quality of writen materials (peers review), quality of presentation (public defense) and deadline respect are most important.

4. Conclusions

The paper considers organization and problems faced during the pilot project based learning course in ASIC design delivered at the Technical University of Sofia. The pilot course was restructured within the framework of the Netpro II EC Leonardo da Vincy Project [6].

Pilot course was successfully conducted and the results are very encouraging. Introduction of PBL in the ASIC Design course enhance student motivation and responsibility; promote competition between students; isolate lazy student forcing them to work alone; give student sense of ownership and control over their own learning.

Activities focus on work similar to real life situation. Discussion, presentation, peer reviews provide students with feedback and learning by experience. Finished products, plans, drafts, and prototypes make excellent discussion topics. Students acquire communication, collaboration, planning and self-evaluation skills.

Among other advantages project based learning enhances English language competency and encourage students to contact and exchange views with colleagues abroad. Problems were encountered in organizing international teams from students working in the same subject in different countries as well as in peer review and assessment. This was because of time scheduling problems concerning start and duration of semesters, difference in educational level because the subjects are delivered in various years of study and the students have different background. All these complicate common team building and peer review and assessment.

Project based learning develops not only subject-matter skills and knowledge; it has major effects on the workplace competences asked for by employers. Students have the opportunity to practice and develop their ability to function in complex environment that reflect the type of work environment they will encounter in the workplace. High among the many workplace skills generated by projects in our classes have been taking initiative, successful team building, cooperative decision-making, group problem solving, developing realistic product and documenting the building process, time management, and even fund evaluating. These are the skills most valued in the workplace and also the hardest skills to teach through traditional teaching.

References

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