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PROJECT BASED LEARNING IN MECHANICAL ENGINEERING EDUCATION

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Abstract

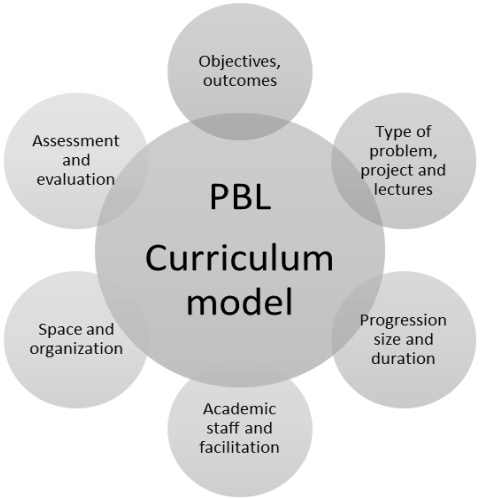
The final year of the three-year bachelor program in Mechanical engineering at Linnaeus University (LNU) consist of applicable, engineering, project based-courses – Machine design B, Product design and development course, and degree project course. Those project-based courses emphasize learning activities that are long-term, interdisciplinary, and student-centred. Project based learning (PBL), as a method that contributes to the active learning of the students; consist not only of learning activities and of understanding the theories delivered but also of working activities where the theory is applied for a problem solving. Students learn about the area of product design by working for an extended period, to investigate and respond to a complex question, challenge, or problem. The project-based courses consist not only of lectures and project but also of seminars, guest lectures and company visits. In this way the students have the impression about the real work at industries and how theories are applied. In this paper, the importance of PBL for mechanical engineering education is presented. The curriculum for the final year is explained and the project-based courses are viewed and compared in terms of implementing PBL together with different pedagogical approaches. The challenges in executing and assessing students work in project-based courses, where students work in project teams, are examined. As a conclusion, the different ways of applying PBL depending on the purpose of the course, will be discussed.

Keywords: *Project based learning, active student-centred learning, mechanical engineering education.*

1. Introduction

In the 70s a problem-oriented and project-organized model was developed in Europe. This model was introduced at Aalborg University and Roskilde University, Denmark, and in the first years at Bremen University, Germany. PBL problems can be small or big, authentic or scholastic, practical or theoretical, etc. There are many combinations of small problems and big projects, and there is a need for a more theoretical definition of PBL that allows for variation in practice. In particular, there are differences in the way the curriculum is organized.

Figure 1. PBL curriculum model (Kolmos & De Graaff, 2015).



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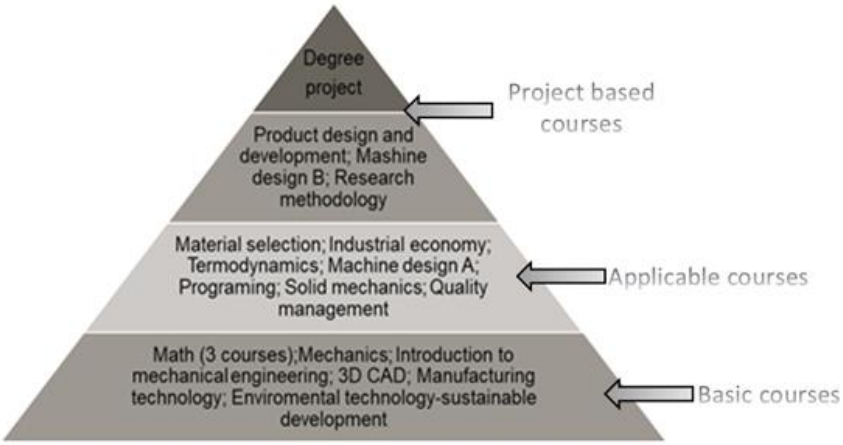
For example, Problem-based learning (PBL) begins when students are confronted with an open-ended, ill structured, authentic (real-world) problem and work in teams to identify learning needs and develop a viable solution, with instructors acting as facilitators rather than primary sources of information. In comparison, Project-based learning begins with an assignment to carry out one or more tasks that lead to the production of a final product – a design, a model, a device or a computer simulation. The culmination of the project is normally a written and/or oral report summarizing the procedure used to produce the product and presenting the outcome.

The PBL curriculum model is linked to the PBL learning principles, but the seven elements have been identified as objectives and outcomes, types of problems and projects, students' learning, progression and size, academic staff and facilitation, space and organization, and, finally, assessment and evaluation, see Figure 1.

2. Methods – variations in practice

The final year of the three-year bachelor program in Mechanical engineering at Linnaeus University (LNU) consist of applicable, engineering, project based-courses – Machine design B, Product design and development course, and degree project course, see Figure 2. Those project-based courses emphasize learning activities that are long-term, interdisciplinary, and student-centred.

Figure 2. The learning pyramid of the bachelor program Mechanical engineering at LNU.



2.1. Curriculum model of the machine design b course

The objectives of the course are to apply scientific theories together with standards and company catalogues to dimension and design different types of mechanical transmissions and drives with respect to loads and selected material. Knowledge about mechanical failures in machine parts is also included in the course.

The task of each student group is to dimension and design a combination drive, of an electric motor, a belt transmission, a gearbox, and a chain transmission, to be used in a lifting machinery. The dimensioning is based on lifting mass, lifting time, and lifting height. The needed power must be calculated so that the electric motor will be selected based on that. All the parts will be dimensioned based on the power the electric motor will deliver.

The project is running during a whole semester parallel with lectures and other activities. There is a 2-hours project meeting every week where every part of the project task will be presented in a progression way. Relevant theories and other important knowledge are delivered in lectures etc. when it is needed for the project work.

The course teacher and examiner are the person who has the full responsibility for the course and the project, but other people are involved in delivering knowledge and support. There are people from industry who are giving lectures in their specialties, at the same time as study tours to industries connected to the project specialty are accomplished.

There is ongoing communication between the teacher (supervisor) and the project groups during and outside the panned project meeting time. Each project group has project leader, and it is the leader, who will communicate with the supervisor. The project meetings are normally in a classroom or a bigger space, but sometimes they must be accomplished in computer rooms.

Assessment and evaluation is partly done during the project work, at the time of project meeting or other time when the project groups are struggling with problem solving and calculations. The supervisor is normally going around and discussing the solutions with the groups. Before proceeding to the next step, every group must explain their work in oral combined with discussions. There are also some moments where the manual calculations have to be checked through computer calculation programs. Finally, each group have to submit a written project report at the end of the course. Written exam about the theoretical part of the course is accomplished in the middle of the course.

2.2. Curriculum model of the product design and development course

The objectives in the course are focused on acquiring the theories needed to apply the product development process in order to handle an open-ended, authentic industrial problem. The outcomes in the course are presented as a 3D CAD models, computer simulations, presentations simple prototypes and written report.

The problem and the project are defined as a first step in in applying the theory and are presented in the introduction of the report. The lectures are planned to follow the steps in the Product development process and a flipped learning is applied – the lectures are available in the platform of the course so every student can read them in his/her own pass and do it as many times as needed.

The course is running during a whole semester, 50 % of the time parallel with the course Machine Design B. The students are working in groups of 3-5 students and they have planned from the beginning that their work will not exceed 20 hours per week (including the individual time to read the theories or to do external research).

The teachers in the course are involved first in delivering a guidance lectures, where it is facilitated and explained the application of the theoretical lectures in the project. There is one such lecture for every step in the Product development process. On second hand there is continues tutoring on the project 1-3 times per step. Therefore, every pitfall in applying the process can be identified early and improved, so that it will not affect the continuous work.

A platform for the course is giving access not only to the lectures but also to the whole information needed to organize the course and to submit the students work. Lecture rooms, meeting rooms and computer rooms are available for the different moments in the learning process.

Assessment and evaluation are done during the oral presentations and apprising the written final report. The biggest challenge is to assess students learning when working in teams. Authors are currently working on developing a method an assessment method for individual grading of group project work.

3. Conclusion

In the engineering field and especially in the field of mechanical engineering, it is both the problem analysis and the problem-solving phases that are important learning phases. Engineers need to know what the problems are, to formulate the requirements, and to solve the problem by development of relevant technological solutions. Furthermore, it is important that these learning processes are team based in order to acquire the knowledge sharing within a smaller team as well, and that the collaboration is oriented toward both process and product so that engineers learn the competence of collaborative knowledge construction. There are variations of in planning and organizing the project-based courses depending on the purposes and objectives of the courses. As it was presented in the method chapter, the last two courses in the mechanical engineering program are project based but they vary a lot. Both of the courses are important for the students to transmit knowledge and to develop skills so that they can handle the degree project, which is done more independently and in smaller groups of two. Problem based courses are more suitable for the earlier applicable courses, while the Project based courses are irreplaceable in the final year of Mechanical engineering education. The feedback from the students is that the Machine design course and the Product design course are the courses that prepare them to manage with the Final project and are the most applicable in their work as fresh engineers.

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