IMPROVEMENT OF TEACHING METHODS AT UNIVERSITY OF WEST BOHEMIA

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Abstract

The main task of universities is to educate a new generation of students and prepare them for their professional career. This is not a simple task. Unfortunately, each university or teacher has to face many obstacles. One of them is the loss of students' interest in study. The reason is simple. The extensive possibilities of our times allow anyone, regardless of education, to work online from home. It is only necessary to know how to use a computer and appropriate software, to know about modern trends (e.g. streaming videos on Youtube) to be creative and to have self-control. Young people like this approach, of course. They do not need to spend years studying a specialized subject in which they will not be employed (e.g. because of low pay conditions, loss of interest in the specialization, etc.). Furthermore, they are not bound by fixed working hours and they are their own masters. All these reasons and many others have caused a decrease in the number of students at universities. Fortunately, there is always an appropriate solution to every such problem. In this case, the solutions are new teaching methods, such as: project-based learning, e-learning, problem-based learning, reverse engineering-based learning, etc.

This article describes the methods of applying these learning tools into the educational model of technical disciplines at the University of West Bohemia in Pilsen. At the beginning, a survey focused on the attractiveness of the existing learning model was conducted. The survey confirmed that it is necessary to change access to teaching. In the first stage, the methodology of e-learning materials was applied. Obsolete teaching materials are replaced by new ones. Teaching material is available online and includes interactive 3D PDFs with models for better visualisation. In the second phase, implementation of project-based learning and problem-based learning takes place. Subjects are modified. Students must work in a multidisciplinary group and seek solutions together. The topics are chosen with a focus on the possible realization of the project. At this stage, students' interest has already been shown. Some students carried out projects in their spare time and gained more information and experience. The current stage is the implementation of reverse engineering-based learning. Students work again in a group on a specific project. However, the task is to modify one of the parts. Students must use machines and tools from the beginning. As they are working on the project, they acquire new information about the importance of the links between individual parts. This process helps them when designing modifications.

Applying these new teaching tools leads to increased interest in learning, while reducing the number of students who do not complete the subject the first time. It also brings lessons closer to practice and facilitates the transition between the theory phase and practice after graduation.

Keywords: project-based learning, e-learning, problem-based learning, reverse engineering-based learning.

1 INTRODUCTION

Industry is an important economic sector in the Czech Republic. It contributes to the sustainability of the economic stability of our country. At this time, the highest representation on the labour market is divided between technical and professional workers (879 000, 17.8%), craftsmen and maintenance workers (851 000, 17.2%), workers in services and sales (746 000, 15.1%) specialists (716 000, 14.5%) and operators of machinery and equipment (642 000, 13%) [1]. These statistics clearly show that more than fifty percent of the workforce must have a technical education. Unfortunately, there has been a loss of students from all technical disciplines. The statistics [2] clearly show that the same trend is occurring in our Faculty. Graph 1 shows the trend of the loss of full-time students and students on distance and combined forms of study. This situation is a problem, not only for the preservation of the University but also for small companies and corporations.

We must realize that there are many factors and reasons affecting students embarking on further studies. The first of them is that the study of technical disciplines is difficult. The second one is the fact...
that students are bored during the courses. The third reason is the range of possibilities of our times. Anyone can, regardless of education, work online from home.

![Graph](image)

Graph 1: Decrease of students at UWB.

Back to the second fact, a survey [3] was conducted at Indiana University which revealed that: “two out of three respondents (66%) are bored at least every day in class in high school; nearly half of the students (49%) are bored every day and approximately one out of every six students (17%) are bored in every class. Only 2% report never being bored, and 4% report being bored “once or twice”. The main reason for their boredom is not the presented topic but the style of presentation. Yazzie-Mintz [3] also presents that: “more than four out of five noted a reason for their boredom as “Material wasn’t interesting” (81%) and about two out of five students claimed that the lack of relevance of the material (42%) caused their boredom. The level of difficulty of the work was a source of boredom for a number of students: about one third of the students (33%) were bored because the “Work wasn’t challenging enough” while just over one fourth of the respondents were bored because the “Work was too difficult” (26%). Instructional interaction played a role in the students’ boredom as well: more than one third of respondents (35%) were bored due to “No interaction with teacher.” So if we derive conclusions from this survey, it is important to move away from old methods of teaching and find new and exciting ways. Fortunately, there is always an appropriate solution to every such problem. In this case, the solutions are new teaching methods, such as: project-based learning, e-learning, problem-based learning, reverse engineering-based learning, etc. Applying these new teaching tools leads to increased interest in learning, while reducing the number of students who do not complete the subject the first time.

2 TEACHING THEORY AND PRACTICE

“Most students deal only with theory at school and they are not able to use their knowledge in practise at their first job so the employer has to spend considerable financial and time resources on the training of the new staff” [4]. The most natural way of learning and also the most effective one is to learn by studying somebody else's work and trying to understand its concepts instead of just learning the theory”. [5] “Theoretical knowledge is as important as the practical one. Without having proper theoretical knowledge, practical knowledge may sometimes prove to be dangerous” [6]. The important conclusion is that it is necessary to connect theory and practice. These new teaching methods bring lessons closer to practice and facilitate transition between phases of theory and practice after graduation.

2.1 E-Learning

E-Learning materials were our first modification of teaching. Obsolete teaching materials were replaced by new ones [7], [8], [9]. Study materials are designed mainly for the students of engineering machine design and technology. Teaching materials are available online [5] and include interactive 3D PDFs with models for better visualisation. All study materials consist of various machine design projects. Each item of study material focuses on one project for a machine or a part of a machine.
These study materials were evaluated by Keckstein et al. [10] and the results clearly show that: “subject completion decreased in previous years, but after the implementation of the new learning materials in the first semester of the academic year 2013/14, the value of completion began to rise and in subsequent years we expect further growth, meaning that the materials will be used to their full extent”. Thanks to the evaluation we knew that we were on the right path and we can jump into the next phase.

2.2 Reverse Engineering-Based Learning

Reverse engineering – based learning is project-based learning with some changes that bring more practical information into the teaching process. At the beginning a group of students is created. The group contains students from several disciplines, and normally contains two or three engineers, an economist, a designer and a consultant from industry. The consultant provides them with practical information and determines the direction of the work. An important aspect is communication with each other and solving the entire project together.

The first step is the phase where the students must perform a literature search focusing on the mechanism. They must find as much information as may be necessary for disassembling the mechanism. Then they can obtain the components. During the course, students use special tools which reveal important information about their product and links to the entire structure of the mechanism. This is the first advantage over Project-Based Learning. The component can be handled, and for example Kristen et al. [11] in their article state that: “…hands-on experiences through the use of “reverse-engineering” projects. As the fundamentals of design techniques are presented, students immediately apply the methods to actual, existing products. They are able to hold these products physically in their hands, dissect them, perform experiments on their components, and evolve them into new successful creations…” This statement only confirms the claim of some who believe that engineering design students are less prepared to do well in engineering, since they lack the experience and intuition that develops from hands on activities from adolescent years.

After students obtain the component, they must propose at least two options for measuring it and determine whether there are the possibilities at the University to do this. If not, they must suggest where it can be externally measured. This step serves to develop communication and social skills. During consultation with a specialist and with a supervisor a variant for measuring is chosen and students must obtain all the dimensions of the component necessary for the next step.

From the values obtained in the previous step the designers must create computer aided design (CAD) models and drawings. They must adjust the CAD model to meet all the requirements of the assignment. In this step they must work mostly with the designers. The purpose is to achieve a balance between design, functionality and manufacturability.

After the students agree, the penultimate step may follow. The task of this step is to come up with a way of producing the component. They must propose at least three variants. Here, the economics student has a role to play. Each variant must have a simple economic evaluation. Students must consult on the various options and must include the differences between single and serial production. Finally, if the possibilities of the university allow it, the component can be completely produced. Alternatively, a scale model is produced for the final step.

The last step is a presentation. Each student has to defend their selected variant and the steps that led to its design and manufacture.

In addition to the required courses, students can also participate in projects supported by our department. At the moment, the biggest project is Formula Student. This project involves a team that is currently composed of thirty students on bachelor and master studies not only at the Faculty of Mechanical Engineering but also at the Faculty of Electrical Engineering, the Faculty of Applied Sciences, the Faculty of Economics and the Faculty of Design and Art. In this project, students build their own formula racing car to compete in the international project “Formula SAE”. The main benefits of this project are improvement of technical and language skills, a great opportunity to get acquainted with new technologies, and gain new experiences. The second project supported by our department is the conversion of a press [12] for educational, experimental and manufacturing purposes.

2.3 Project-Based Learning

Project-based learning has been created at the Department to eliminate the main disadvantages of e-learning. The subject which focuses on this methodology is the Theory and Methodology of Machine
Design Engineering. And as the guarantor of the course, Professor Hosnedl, describes on the University website [13]: “The aims of the course are to provide students with grounds of the knowledge system of Engineering Design Science (EDS) about and for system management and creative design engineering and evaluation of technical products considered as technical systems (TS) which are based on complex requirements resulting from their operational process and other phases of their life cycle. EDS knowledge unlike traditional instructive oriented methodologies for design engineering of TS structured into systematically interconnected ‘map’ of: descriptive (theoretical) knowledge related to TS and engineering design process; prescriptive (methodical) knowledge related to TS and engineering design process, both interconnected with both technical and other supported science and practice fields as well as computer and experimental tools, which brings important synergy effects”.

Project-Based Learning is similar to Reverse Engineering-Based Learning, but manual skills are not involved in conventional teaching. The principle of the course is based on solving real tasks which are specified by engineering design firms. At the beginning, students are divided into several groups. During the course, students must conduct market research, design several variants, evaluate these variants and select one and create design solutions for the chosen draft. The final step towards completion of the course is presentation and defence of the work in front of a professional jury composed of the heads of departments.

3 CONCLUSION

It is certain that the loss of students creates problems not only for universities but also for firms. For this reason, our long term goal at the Faculty of Mechanical Engineering at the University of West Bohemia is once again to attract students back. Also, to reveal them the mysteries and beauties of technical disciplines and to show them that this specialization is worth studying. Of course it is very important that companies express the same desire. If the improvement is only on one side, there is no chance of achieving the desired effect.

The next step is an evaluation of these applied tools and a modification based on students' comments. This step is very important because it is necessary to keep up with the requirements of the students.

REFERENCES


