STUDENT CREATIVITY AND MOTIVATION IN EDUCATIONAL PROCESS – CASE STUDY

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ABSTRACT
The change in the curriculum at The Faculty of Mechanical Engineering, University of Ljubljana, was an opportunity to influence the students' perception of the design and the new product development process. It is well known that case-study work stimulates the interest also for theory, however, the one step further that we took, was to build the case study on each student's personal experience. Personal involvement in the development process appeared to enhance the interest for problem recognition and the motivation to solve it. Later, this motivation became the fundament for student creativity during the study of the product development process. The whole study and development process was followed by coaches through the reports which were prepared by the students as well as statistically with the qualitative and quantitative questionnaires.

Keywords: Creativity, motivation, engineering education, team work, product design

1 INTRODUCTION

The change of the curriculum program of the Faculty of Mechanical Engineering, University of Ljubljana is in progress. Several courses have been changed or added in the design field to follow actual trends in the engineering world. A lot of additional effort has been invested to teach students modern modeling and design techniques which were insufficiently represented in the old study program.

However, according to our teaching experience it was often a problem for the students to understand and achieve an important step between 3D shape-giving by use of different CAD software and actual design process, which demands to pay the attention not only to shape, but also to a product function, manufacturability, assembly, use, etc., having in mind all factors of product success in the global market [1]. All these factors have an impact on the modeling process and have to be considered in-depth during the modeling process.

In the Laboratory of Computer Aided Design we have more than 10 years of experience of teaching students the modern methods of new product development in a competitive environment of a global market. Namely, the international European Global Product Realization course has been established by three European universities to give students valuable experience of design on real industrial cases. During the past few years the course expanded to six participating universities [2-4].

The basic idea of the new course, called Product design and development (PDD), was to prepare the students for the course of Design methodology and to enhance the knowledge of computer modeling which was started with the course Space modeling. However, the most important message of the course is that computer modeling is only a tool for the complex process of product design and development.

2 HOW TO MOTIVATE STUDENTS?

Maslow theorized the existence of five basic human motivations which are active in hierarchical order. That is, as one becomes satisfied, the next one in the hierarchy becomes dominant [5]. Research (i.e. [6]) has however shown that within the working environment the basic needs for physical satisfaction, safety and the sense of belonging are already satisfied by actually having work, so the focus placed should be on esteem and self-actualization. These two motivational categories are also the ones most widely connected to creativity, sense of a mission and professional creativeness [7]. As creativity is considered to be one of the major contributors to effective product development, these are the motivational aspects to be considered in motivating the students within the educational environment.

Creativity is exhibited when a product is generated that is novel and useful with respect to the firm [8]. A creative output must be relevant, effective, appropriate, and offer a genuine solution to a particular problem or presented task [6].
To motivate the students in an educational process has always been a challenge and sometimes also a problem. Of course administrative mechanisms exist to motivate and stimulate students to continue and finish their study, e.g. scholarships, student benefit status, etc., however, this kind of stimulant usually does not enhance the creativity as well. On the contrary, in some cases this kind of stimulation can even inhibit creativity [8].
For that reason a decision was made to find a new way to stimulate the students to be more creative in their study process, based on strengthening the sense of self-accomplishment and which would enhance the success or transition rate of the course which was started anew.
The PDD course program was inspired by the international EGPR course (Figure 1 and was adapted to the needs of the new study program. The both courses are based on problem solving; the difference is only in the provider of the problem. The EGPR course includes a real industrial partner which provides the case problem to be solved while the problem for the PDD course is chosen by the instructor, since the main problem has to include specific sub-problems which has to be solved for students to obtain specific knowledge. In the study year 2010, the problem was to design an innovative docking/charging station for a mobile device, where each team and student developed the design for his own mobile phone or any other portable electronic device. In the case of this station, students had to solve interdisciplinary problem, starting in the first phase with market analysis, product analysis and customer research while in the second, development phase they achieved the basics of design methodology, and knowledge about 3D surface measurement, acquisition and reconstruction as well as free-form modeling with CAD software.

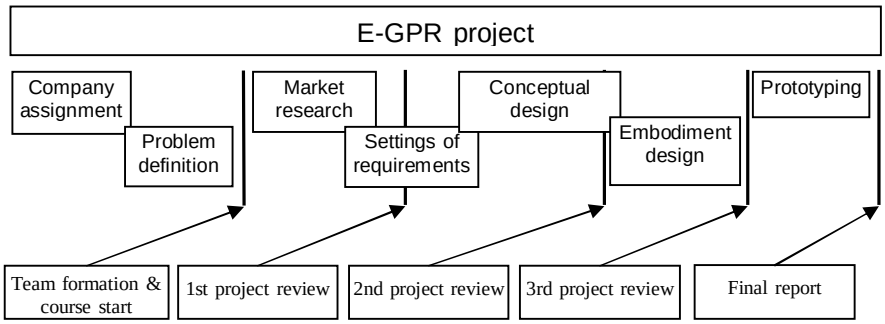

Figure 1. Process plan of the international E-GPR course

The first major change was done in the organization of the teams. The PDD course consists of two major phases, or sub-units, similar as in some industries [9, 10]. As in the EGPR course, the first phase of PDD course starts work with the teams of 4-6 students working on the same project (Figure 2). This is important, since it is well known that working in a team significantly stimulates the motivation due to the feeling of belonging and responsibilities towards the team, which can be even more enhanced by a good team leader and positive team relations [11, 12].

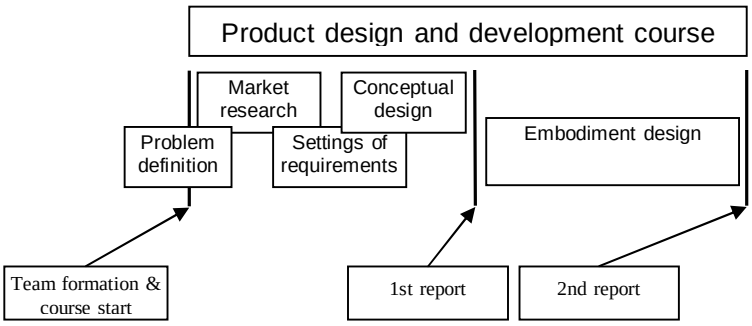

Figure 2. Process plan of the Product design and development course at the faculty of Mechanical Engineering, University of Ljubljana

The second change was made in the organization of the second, detailed design phase of the project, when teams were disbanded and each student worked on their own case, initiated by the whole team in the first phase. This organization brought three major benefits. Each student was immediately motivated by working for his or her personal product; each student was able to express his or her own creativity with no team limits; while the third benefit was for the instructor who was able to evaluate each student individually.

3 RESULTS

Since, the course just took its place in the curriculum program we were interested in the results of the course described by two parameters: the percentage of positive marks and among those the average mark. Besides that, we also made several interviews with the students to get qualitative feedback about the educational process. The results were compared with three other courses, which were led by the same staff of the laboratory. For the comparison we analyzed the course Space modeling which is given to the first year graduate students; Non-metal material constructions are given in the first year of master study and Product design in the second year of master study, but to students of production engineering.

If we look at the Figure 3, we can see that the new course called Product design and development gave the highest rate of transition. This results confirms our statement about motivation, although the course demanded of the students an additional effort compared to the other courses, which are given by the same laboratory or even by the other instructors from the Faculty. This can be derived also from the statement of one of the interviewee, who said: "*The course took me really a lot of time, sometimes even on account of the other courses, but anyway, I liked the project.*" Of course, we have to consider the differences among different courses. For example, the course Space modeling, is given to first year graduate students who are still searching for the focus of their interest and adapting themselves to higher education working process, and therefore sometimes lacking the motivation, which can also be seen in the results of the course transition.

On the other side, the background profile of students who were attending the course of Non-metal constructions is very similar to those, attending Product design and development – they attend the same study program and are in both cases third or fourth year experienced students. The courses are given by the same instructors, so the differences in the teaching experience and style, evaluation criteria and demand can be eliminated. Even in this case we notice a 5% difference and bigger course success in the case of the new approach.

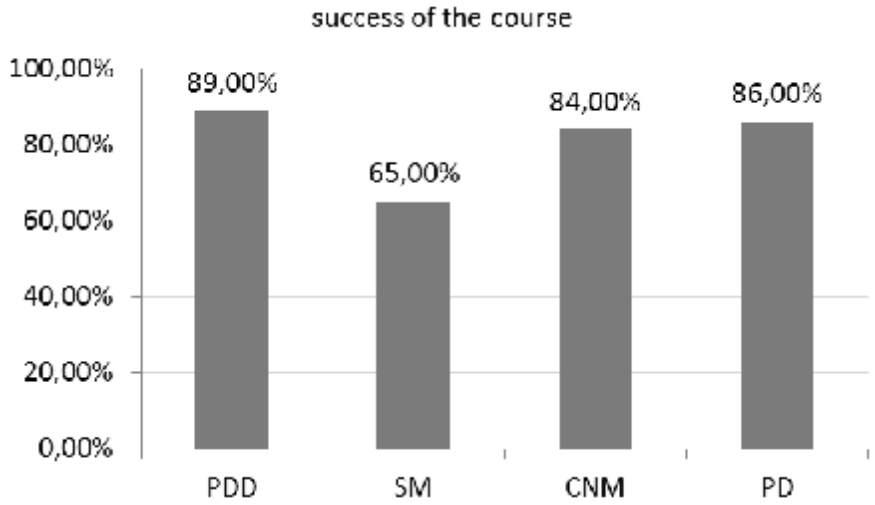

Figure 3. Percentage of student who successfully finished the practical part of particular course in the year 2010

On the other hand, the new approach driven by personal motivation did not have much influence on the average mark, as can be seen from Figure 4. The highest average mark was achieved by the course Product design which is a course for the students of production engineering in the fifth year of their

study, but follows a program very similar to Space modeling from the first year of the renewed graduate study program.
The results show that in four years of their study the students better achieved the difficulty level of the course, while selection also did its job and we could expect similar results also in the case when Space modeling would be in the fourth or fifth year of a study program. If we look from the opposite viewpoint, the good average marks achieved at Product design were expected since the course program is adapted to first-year graduate students.

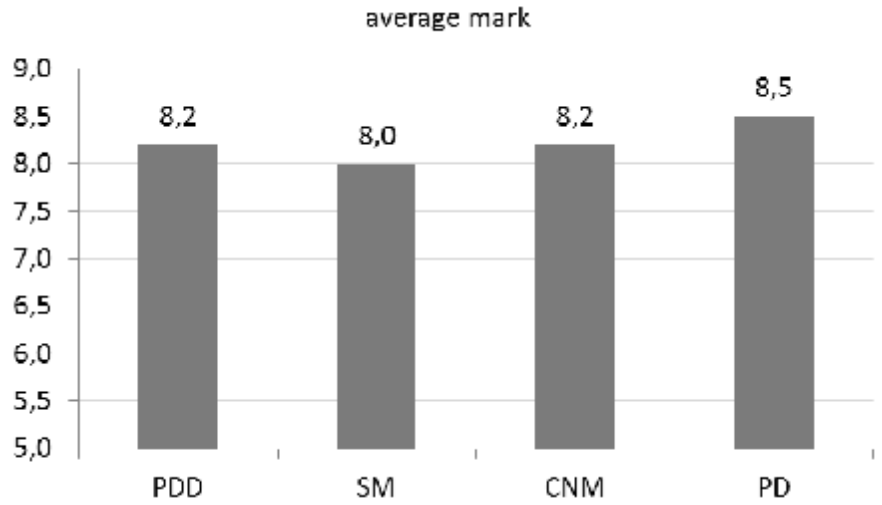

Figure 4. Average mark of students who successfully finished the practical part of particular course in the year 2010. Value 6.0 is the first possible positive mark

Here we have to point out, that the results reflect on the school year 2010, and the results could vary slightly through the generations. However, they do give some insight into the quality of the courses, and give directions for the following years. Hereby we can notice, that there is still space for the improvements in the following years.

4 CONCLUSIONS

In this paper we briefly introduced the results of an attempt to increase the motivation and creativity of student in their study process. The renovation of study system and curriculum at the Faculty of Mechanical Engineering, University of Ljubljana, was a great opportunity to do that, since a new course was introduced into the study program, and the Faculty and Laboratory staff has had a lot of pedagogic experience in the field of CAD modeling, product design and as well in student education. Following modern trends in university engineering education around the world we got several ideas to stimulate the motivation and enhance student creativity which we integrated into the new course of Product Design and Development. The statistical results, which are regularly monitored at the Faculty showed the improvement of these motivation approaches in the course success, while we did not notice any larger impact on the average student mark of the course.
The described results derive from the first year of the new course and showed the improvement of the renewed study program. However, we still believe a lot of monitoring has to be done still in the following years, while there is still space for additional improvements in terms of motivation which would result in higher average marks as well.
This could be obtained in several different ways, including introducing a real industrial partner, work in virtual teams, expanding the course to the materialization and prototype production, combining the course with the internship which usually also gives students some material support.

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