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LEARNING ABOUT METHODS OR WORKING METHODICALLY

Valentina Haralanova[1], & Göran Fafner[2]
[1]*Department of Mechanical Engineering, Linnaeus University (Sweden)*
[2]*Design Department, Linnaeus University (Sweden)*

Abstract

After gaining some years of experiences working and teaching in the field of Product design and development authors are presenting their reflections on the students' performance, the result achieved in the project based course but also their critical thoughts about the problems faced during their work.
In the last 7 years the course was redesigned and developed taking in consideration our own performance and result in training students to build competences in handling and solving design problems but also following the research in the area.
The problem highlighted in this paper is: regardless the well planned course content (including theories about product development process, different techniques and methods to define and solve the problems); neither matters how well the project tasks have been selected; the result from the course depends very much on how the students are taught to think and understand the process they have to apply. To teach them in so called "design thinking" it seems the biggest challenge for the university teachers in this interdisciplinary subject, because it is not only about gaining a knowledge in the subject area and development of skills to manage design problems but it is about achieving better students` performance. It is also to develop a "designer intelligence" - an ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviours within an environment or context. (Mackay, 2018)
The research question for this paper is- "Is there a way to train students not only "automatically" to apply the methods learned but also to develop a holistic understanding about the product development process, competences and intelligence to work methodically on it?"

Keywords: *Higher education, project based learning, product design and development, development of intellectual capabilities, design intelligence.*

1. Introduction

1.1. Background

The course "Product design and development" at Linnaeus University, Sweden has over a decade history. The course is given mainly for mechanical engineering students; undergraduate level; third year. The course had duration of one term (approximately 8 weeks), 50% study time. One of the authors of this paper took over the responsibilities for the course seven years ago. The same syllabus was followed and the same course literature – "Getting design right – a systems approach".

Following the best practices in engineering higher education; understanding the interdisciplinary nature of the Product development process in the reality; and perceiving the need of teamwork done by specialist from different background, the course was redesigned to a project based course, with industrial projects and project groups of students were to work on it.

The Project based learning has been recognized, by the research in the area, as one of the most effective teaching frameworks for engineering courses. Benefits of applying project based learning approach occur via developing cognition (critical thinking), skills (e.g. teamwork, good oral and written communication, time management, etc.), and attitudes in the students. (Zancul, Sousa-Zomer, Cauchick-Miguel, 2017).

The industrial projects have been carefully selected – in order to reflect how the subject evolves; to take in consideration students' background. The problems were selected not to vary too much, so to keep similar difficulty and amount of work for the different project groups. A planning for the projects was done; so that the students could manage with performing of all the steps planed in the product development process and manage with the scheduled deadlines.

After having the course in six years and gathering some experiences a re-design of the course syllabus was planned for the fall 2018. Firstly, a need of changing course duration was recognized. It was ambitious and difficult for the students to fulfil all the requirements for the project in less than six real weeks (November – December). Something more, the authors have more than 30 years of teaching

experience in engineering graphics and they are fully convinced than development of Visual-spatial intelligence (Carroll, 1993) of students needs to be distributed in time. It needs time space so the new ability to be realized and applied by the student. The course from autumn 2018 has been planned so, to be placed in two terms (September-December).

Secondly, a need of adding some content of industrial design theory and practice was recognized and satisfied. A second teacher with corresponding background was involved in the course.

1.2. Problematization

The good organization of the course, the balanced schedule, rich of different activities, like company visits, guest lectures from the industry, industrial projects and project seminars resulted in one well appreciated by the students course. The faculty sees the positive sides of the new course syllabus but striving better course syllabus and better student performance some critical recapitulations and conclusions were done:

- The content of the course was well balanced and planed;
- Study visits and guest lectures from leading companies in the region have made the course unique and proved for the students that the theories, they were taught, are applicable in the reality;
- Despite the students were asked before the course start about their wishes about the type of products they wish to work in the projects, and those wishes were fulfilled they worked not with the expected inspiration;
- The time planned for project work was not used efficiently by the project groups;
- The main issue the faculty faced was the way students applied the theory for the different steps, because this affected the result of their work the most.

For each step of the Product development process different tools were presented in the theory, methods and techniques were studied, so that the process could be executed in the right way. Application of those methods needs a deep understanding of the process and perception of what exactly is the logical sequence in the methods used in the different steps - from defining the problem to development of a good solution. It is needed, almost in each step that the student is aware about the input data, to "dive", analyse, study it, and then to "surface", synthesize and define the result of the step, as an output from it. It needs abstract thinking and sense about the systematic approach to solving a problem.

The teachers in the course noted some weaknesses in students´ performants. Their work on completing the project tasks could be describe like flowing in two parallel lines. The one was to try to follow the product development process, attempting to apply the methods learned in a superficial way, without deep understanding and without using the achievements in the next steps. While the second one was to work on solving the problem in completely unstructured and not systematic way. In addition, there was any coherence between those two lines.

This observation made the faculty to set the question of this study – "Is there a way to train students not only "automatically" to apply the methods learned but also to develop a holistic understanding about the product development process, competences and intelligence to work methodically on it?"

2. Objectives and methods

Objective of this study is to develop a new approach to the learning process that will result in better students´ performance. The effect of this new model should result in more developed intellectual skills applied in the six fields defined by (Bloom, 1956) as follows:

- Knowledge - the acquisition of knowledge as the subject to study, and also the related areas;
- Comprehension - understanding of knowledge, organization and relating the new knowledge with previously learned, restructure the information and interpreting the main ideas;
- Application - using the new knowledge, following certain principles, in new situations;
- Analysis - critical thinking, concentration of attention on individual pieces of information, their importance as a whole, ability to compare ideas ant to make conclusions, formulate hypotheses, assumptions, ability to "dive" into the problem;
- Synthesis - critical thinking, focused on connecting selected, pre-analysed data parts into new knowledge, ability to generalize, to "surface" and formulate a final conclusion;
- Evaluation - critical thinking, focused on formulation of a judgment, an assessment, ability to determine the accuracy and reliability of facts and data selected to prove the method and the result.

Actually, Bloom´s taxonomy was one of the basic approaches when the syllabus for the course was developed.

In the subject area of Product design and development the outlined intellectual competence, applied in the six defined fields, could be named "design intelligence". The main purpose of the new approach to the learning method is to enhance the "design intelligence" of the students.

The methods of this study are based on a two popular models. One is the "cone of learning" or also called "learning pyramid" according (2014). The second one is the 70.10.20 model for learning and

development of competences. (Camarda, 2016) The both methods are well known, they appear in many publications in different subject areas. From other hand both of the models have been debated, they are controversial and have weak empirical bases. Despite that fact, both of the models have been used in this study as milestones in analysing the weaknesses in students` learning and to define new strategies for enhance their performance by development of new intellectual competences.

3. Design

Based on the objectives and methods presented in the previous chapter an improved learning model for enhancing the students' performance in the course Product design and development has been suggested:

- The active, project based learning will be the base of the course;
- Even more careful selection of the project tasks has to be done so that the product in design and development scope will inspiring for the students, with a structure close to their background but also providing enough wide design space to free students creativeness.
- Participatory teaching methods are to be more widely applied – re-designing the classical type of lectures in discussions, students will be involved in "teaching others" activities;
- Demonstration and presenting educational examples will be used in order to understand the logical connections in the process and to develop an abstract thinking;
- The industrial design content of the course will be taken fully in workshops sessions;
- Deadlines are to be planed weekly instead for the three main phases of the process, different type of presenting the result for each deadline will be required – seminars, presentations, models, written document, so that the intensity of work on the project is constant, and there is a lull and then overload;
- Feedback will be intensified – for each deadline, weekly;
- Learning by doing is to be applied – firstly applying the different tools and methods in the process, but also the practical work will be intensified, involving students not only in sketching and virtual modelling, but also in building different models in the different steps of the process- scaled models, paper models, 3D printed models etc.
- New requirements to the report writing are to be defined.

4. Conclusions

As teachers at university, we are in a constant urge to improve the quality of the product of our work. In this process, we are dragged by the intention to have successful students, performing well, with highly developed knowledge and intellectual capabilities and we are pushed by so many requirements to the education from different parts.

Already after the first run of a new course an observation could be done what is good, what is week and what could be improved in the teaching methods and learning models. In the study, such analysis was done based on two popular models – 70.20.10 model for learning and development and the learning pyramid. The main problem was found to be the lack of deep understanding of the methods learned and their superficial application, so that they cannot contribute to one methodical and successful process of product design and development.

Some new approaches, to the learning model, have been proposed, in order to improve the learning model and to conduce to development of specific intellectual capabilities of the future engineers that we can name "design intelligence".

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