

## A survey of student-centred approaches to engineering education - a case study concerning Slovenia and Thailand

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**ABSTRACT:** Contemporary technologies require continuous development of curricula, course contents and laboratory practical classes. However, the teacher-centred teaching approach seems still to dominate in engineering education when compared with more active teaching methods that are oriented towards student-centred learning. This article overviews the cognitive levels in engineering education related to the revised Bloom taxonomy, where student-centred methods can contribute more to higher cognitive levels of knowledge. To examine how engineering educators are qualified, a survey was undertaken at two universities in Slovenia and one in Thailand. The analysis of the questionnaires obtained from engineering educators revealed that they seemed to be dissatisfied with the knowledge, skills and motivation of freshmen students applying for entry to engineering programmes. Respondents were aware of the advantages of student-centred approaches, despite their theoretical knowledge being weak, while their capacity for practical implementation of corresponding methods was considered to be much better.

### INTRODUCTION

Incorporating advanced technologies in a study programme is a challenge for engineering education in various aspects. Among other issues, engineering educators need to consider:

- contemporary content of the courses;
- state-of-the-art appliances and devices;
- potential of e-learning;
- teaching methods and approaches.

The most obvious aspect in contemporary engineering education is how to incorporate topics about recent developments in technology into the syllabus. Even though students and employers expect state-of-the-art course content, it is not straightforward how such topics should be introduced without being detrimental to fundamental knowledge. Furthermore, new technologies are often complex and require adaptation of learning content in line with the students' prior knowledge. For example, one emerging theme is nanotechnology. This multidisciplinary field is a result of progress in science and engineering at the nanoscale so, consequently, there is a demand for specific professional knowledge and skills [1].

In electrical engineering, fast development of embedded systems requires the implementation of complex hardware facilities incorporating, for example, an ARM9 based reference platform [2]. Furthermore, remote laboratories in science and engineering are a solution for construction of real (not virtual) experiments and exercises in a distance-learning manner [3]. Computers equipped with data acquisition systems (DAQ) have become a part of laboratory apparatus as reported about computerised laboratory activities in a course on the operation of electrical machines [4]. While contemporary technologies influence engineering education significantly, implementation of contemporary teaching methods and approaches have been less noticeable. Educational psychologists classify learning objectives into three *domains*: cognitive (knowledge, mental skills, processing of information), affective (attitudes and feelings) and psychomotor (manipulative or physical skills). The most prevailing in the cognitive domain is the so-called Bloom taxonomy (classification) first published in 1956 [5].

Later on, the taxonomy was updated, hoping to add relevance for 21st Century students and teachers [6]. The revised Bloom's taxonomy introduced the following six cognitive levels quoted from lower to higher order thinking skills:

- remembering - recall or remember the information;
- understanding - explain ideas and concepts;
- applying - using information in a new way;

- analysing - distinguish between different parts;
- evaluating - justify a stand or decision;
- creating - create new product or point of view.

The three lower levels as hierarchically ordered are necessary in learning processes. However, the three higher levels may be considered as parallel. Lower cognitive levels are not necessarily easy for students and high levels are difficult. For example, remembering (1st level) may be difficult if there is a lot of information to remember. Creating a new product (6th level) can be easy if students are highly motivated.

Learning processes are not always necessary for starting with lower and following by higher cognitive levels. For example, one can start with applications before introducing concepts. From this viewpoint, two distinct and opposing instructional approaches are inductive and deductive. In deductive teaching (rule-driven, top-down), the educator typically provides information on rules and general principles, describes or demonstrates chosen examples to confirm the concept and, finally, gives students a chance to practice, evaluate and create. In inductive teaching, an educator provides real-world examples; then, the students practice in order to figure out the general concept and rules by themselves. While deductive teaching is more teacher-centred, inductive teaching is student-centred. Learning is supposed to be a balanced combination of both approaches in order to achieve comprehensive and effective knowledge and skills. Deductive instruction seems to be dominant in engineering and science teaching [7]. To develop higher cognitive levels, the authors emphasise inductive teaching methods dividing them into:

- inquiry learning;
- problem-based learning;
- project-based learning;
- case-based teaching;
- discovery learning;
- just-in-time teaching.

#### A SURVEY OF STUDENT-CENTRED APPROACHES OF ENGINEERING EDUCATORS - A CASE STUDY FOR SLOVENIA AND THAILAND

However, how qualified are engineering educators with didactic theories and by studying examples of good practice to implement more student-centered activities? Inquiry on this issue was undertaken at two universities in Slovenia and one university in Thailand. In March 2012, an on-line questionnaire was prepared for engineering educators from the University of Ljubljana, Slovenia (Faculty of Electrical Engineering and Faculty of Mechanical Engineering), the University of Maribor, Slovenia (Faculty of Electrical Engineering and Computer Science) and Burapha University in Thailand (BUU). Forty-nine educators filled out the questionnaire; unfortunately, only seven of these were from BUU, too few to allow for a comparison of the Slovenian and Thai cases. Forty-two respondents were male, seven were female; the average age was 42 years (ranging from 27 to 75); and they had been higher education teachers for an average of 13 years (ranging from one to 34 years).

The first section of the questionnaire was about the perception of respondents about students, skills, knowledge, experience, etc. The answers to the statements were based on a five-point Likert scale, from 1 for *strongly disagree* to 5 for *strongly agree*, 3 is considered to be neutral. The first statement was *Knowledge and skills of freshmen students in science, mathematics, technology, ICT, ...is adequate and sufficient for the programme they applied for*. The average score was 2.5, see distribution in the left-hand diagram in Figure 1, which shows that respondents are not satisfied with the freshmen students' knowledge and skills. On the other hand, the statement that *Over the last few of years, knowledge and skills of freshmen students in science, mathematics, technology, ICT, ...has got worse* was much more agreed with. The average score was 4.0, distributed as shown in the right-hand diagram in Figure 1.

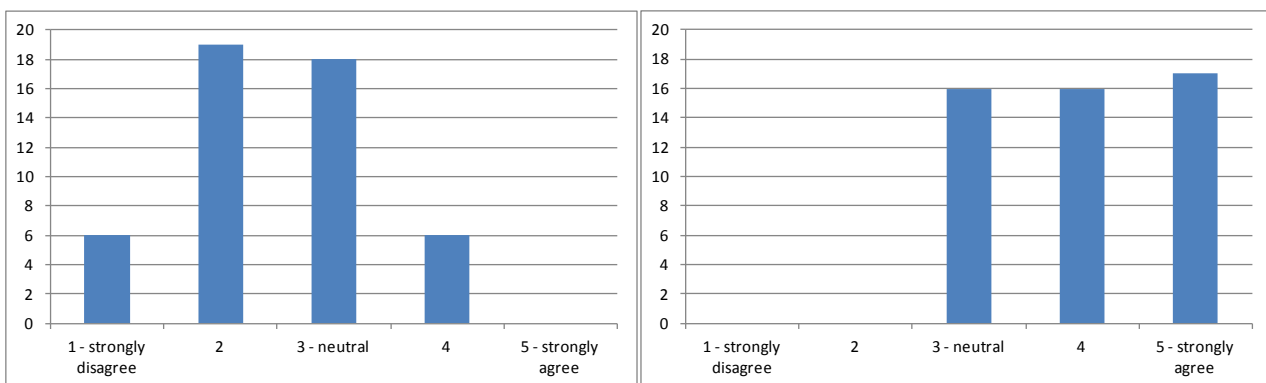


Figure 1: Distribution of answers about adequacy of knowledge and skills of freshmen students (left) and knowledge and skills in recent years (right).

Furthermore, it was generally not agreed that freshmen students are properly motivated to study their programme, as shown to the left of Figure 2. Consequently, educators agreed that university should be more concerned about pre-higher education in order to improve the overall quality of freshmen students.

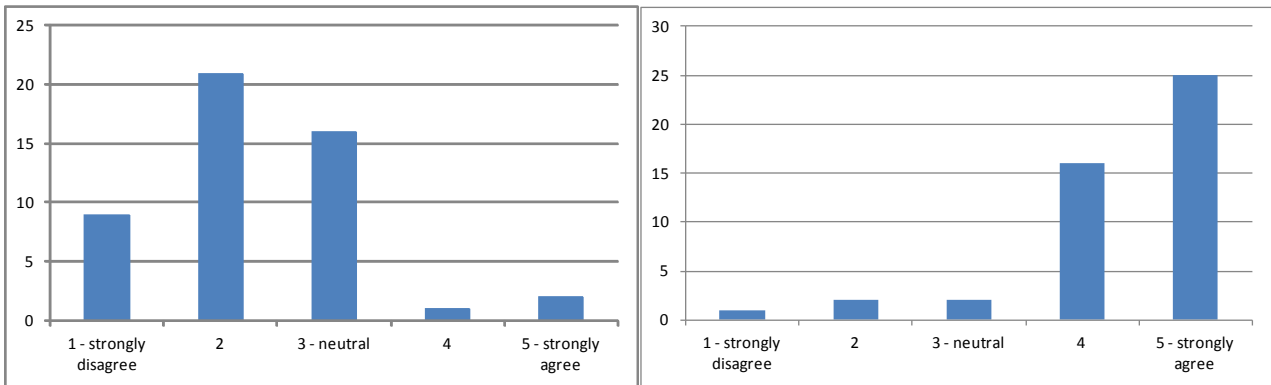


Figure 2: Perceptions about motivation of freshmen students (left); perceptions about university concern about pre-higher education (right).

The second section of the survey was about how familiar engineering educators are about terms and teaching strategies and approaches, all concerning student-centred methods. The answers to the statements were from 1 for *not familiar* to 5 for *very familiar*, value 3 is considered to be neutral. The first question was how familiar are respondents about cognitive levels of knowledge (according to Bloom's taxonomy).

The average *score* was 2.3 (see left-hand diagram in Figure 3), so most educators were not familiar with or were poorly familiar with the psychology of education regarding cognitive levels. Despite that, most respondents considered the importance of cognitive levels of knowledge taxonomy when testing students' knowledge (average *score* was 3.6) as shown in the right-hand diagram in Figure 3. Respondents also believe that it would be rather important to acquire more theoretical knowledge about education and pedagogy. The average result for the importance was 3.7.

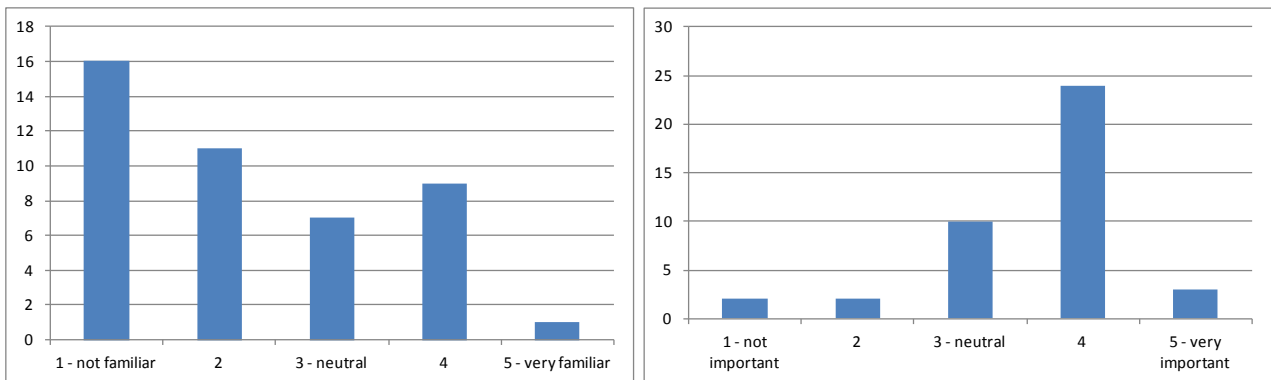


Figure 3: Educators' familiarity with cognitive levels of knowledge and its taxonomy (left); perceptions of the importance of cognitive levels when testing students (right).

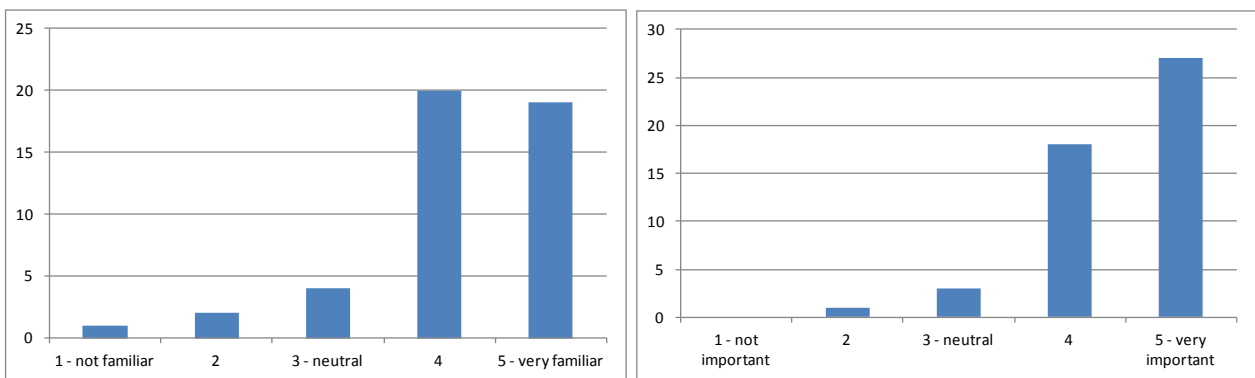


Figure 4: Educators' familiarity with the practical implementation of student-centred teaching approaches (left); perceptions about the importance (right).

Teachers in higher education were much more familiar with the practical aspect of student-centred methods compared with their theoretical background. They considered themselves somewhat familiar in implementing learning by experience and by inquiry, learning by doing, project oriented learning etc, as shown in the left-hand diagram in Figure 4. The coherence of responses was even greater regarding the importance of mentioned approaches (right diagram in Figure 4).

## CONCLUSIONS

The engineering educators who responded to the questionnaire seem to be dissatisfied with the knowledge, skills and motivation of freshmen students applying engineering programmes in Slovenia and Thailand. They agree that educators in higher-education should be more concerned about existing situation and become more involved in improving pre-higher education; namely, by popularising science and engineering to middle and senior high school students.

Respondents' knowledge about the theoretical background of cognitive levels and knowledge taxonomy was weak but they were aware of the importance of acquiring more theoretical knowledge, and believing it to be important to employ different cognitive levels when testing their students. Engineers teaching at the three universities included in this survey were more familiar with practical implementation of major student-centred approaches, as well as considering this to be particularly important.

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