Students' Perception of Applied Educational and Pedagogical Approaches at Stem Universities

A European Overview

Nørgaard, Bente; Beagon, Una; Koponen, Juha; Kövesi, Klara

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STUDENTS' PERCEPTIONS OF APPLIED EDUCATIONAL AND PEDAGOGICAL APPROACHES AT STEM UNIVERSITIES: A EUROPEAN OVERVIEW

B Nørgaard [1]
Aalborg University
Aalborg, Denmark
ORCID

U Beagon
TU Dublin
Dublin, Ireland
ORCID: 0000-0001-6789-7009

J Koponen
Metropolia University of Applied Sciences
Helsinki, Finland
ORCID

K Kövesi
ENSTA Bretagne
Brest, France
ORCID: 0000-0002-4036-6475

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[1] *Corresponding Author*

B Nørgaard

bente@plan.aau.dk

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ABSTRACT

Engineering (STEM) universities in Europe apply different pedagogical and didactic approaches, which are reflected in the structure of teaching and learning activities that are organised for the students. There is great variation in terms of both semester structure and how teaching activities are carried out. The aim of this study is to shed light on students' observations of the different teaching structures and teaching practices offered and to highlight the impact on students of the different teaching approaches.

The data for the study was collected through a survey distributed by the BEST student organisation with 351 respondents from students in 36 European countries. The survey contained multiple-choice questions that aimed to collect demographic data, but also focused on questions about how their programme and learning and teaching activities were structured and most importantly, their perception of the various approaches used.

Findings show the variation in teaching approaches such as the extent of teacher centred approaches, class sizes, laboratory components and project work. The variation in the delivery of project work, the number of projects, timescale and the extent of collaboration with industry are also described.

The study shows a picture of EU engineering universities from the perspective of the students. It highlights the diversity in structure and teaching activities and most importantly, the extent to which students disengage due to the way they are taught.

1 INTRODUCTION

Engineering education, in general, is very focused on how to develop the skills and competencies of engineering students, as new expectations and requirements emerge even faster each year. Concepts such as Industry 4.0, which requires competencies in digitisation and the UN's 17 SDG goals which provides a framework for sustainability, are both concepts which require universities to continuously develop their educational programmes. To meet this dynamic, it is important that universities not only pursue 'what to teach' but also progress their pedagogical and didactic methods by also pursuing 'how to teach'. Engineering institutions in Europe apply different pedagogical and didactic methods, which are reflected in the learning activities that are organised for the students. These activities provide students with different experiences in terms of both approaching their learning and their ultimate achievement.

The aim of this study is to shed light on the following questions: What are students' perceptions of the different teaching structures and teaching practices which are provided by European engineering universities and how do students encounter these different teaching approaches.

2 LITERATURE REVIEW

Understanding engineering students' perceptions of their teaching and learning experiences is an important issue in order to develop efficient, attractive and motivational engineering programmes. According to a study by Korte and Smith [1:12] engineering 'students often reported their most important learning occurred in labs and small group discussion sessions, as well as in study groups'. These teaching and learning experiences in small classroom settings not only encourages active learning but also offers opportunities for direct feedback. They also enhance contact and strengthen the social relationship between students and their lecturers by developing positive emotions and a good classroom atmosphere [2]. In their study, Klegeris and Hurren [3] investigated the impact of using PBL (Problem Based Learning) approaches in a large classroom setting and found a significant positive effect on students' motivation to attend and participate in the classwork.

As highlighted by Parpala [4], students' positive experiences of their teaching and learning environment results in a positive influence on deep learning approaches and negatively on surface learning approaches. However, we have to highlight that there are important disciplinary differences between students' perceptions of the concept of 'good learning'. In STEM disciplines, the analysis of students' best learning experiences showed that students more often refer to their motivation and emotions rather than the content or environment used in their learning [5] confirming the importance of social relations in engineering education [2].

Tayebi et al. [6] noted that having a poor relationship with professors is one of the major reasons that students drop out in engineering. The top two reasons were the difficulty of engineering studies and poor grades. Their study revealed that 46% of students have thought about abandoning their engineering studies. This is most likely related to the commonly recognised difficulty of undertaking engineering studies (identified as the first cause of students' dropout). Salas-Morera et al. [7], report that several pedagogical and organisational factors increase the likelihood of students abandoning their engineering studies. These include; inadequate class timetables or planning of exams, overloaded and long syllabi with too many targeted activities, the high level starting point of many courses and difficult exams.

It is widely recognized that university-industry collaboration is highly beneficial for developing engineering students' industry oriented professional competences. The implementation of PBL practices at the project level through partnership with industry seems to be a well-adapted and efficient way to create an emerging learning environment in engineering education. Surprisingly, based on a recent meta-analysis by Chen et al. [8], there are relatively few studies reported in the academic literature with collaboration between university and industry at the project level.

3 METHODOLOGY

This study has an explorative approach with the aim to explain students' perception of educational and pedagogical approaches applied at various STEM universities in Europe. The work is intended as a feasibility study on students' perceptions, behaviour, and preferences from which concepts and hypotheses can be drawn up for more comprehensive research. It was conducted as part of an Erasmus + research project on the future of engineering education, the A-STEP 2030 [9][10]. The data was collected through an online survey using the software, SurveyXact. It was ethically approved by Aalborg University and disseminated through the Board of European Students of Technology (BEST) network.

The survey was divided into three main parts. The first part focussed on demographic variables which depicted the students. The second part of the survey included two open-ended questions related to students' experiences in the classroom. These two questions are not part of the analysis presented in this paper. The third part contained questions that sought answers to students' perceptions of learning activities and their study structure. There were 351 respondents to the survey, however 303 completed the demographic information only and 108 completed all questions on the survey. It appeared that the 303 students became stuck in the open-ended question part of the survey and did not move on. However, 108 responses were determined to be valid for the analysis.

In total there were a vast range of Universities represented in the survey from 31 identified countries in Europe (11 from Other). Twenty four European nationalities were identified with 80 (26%) respondents indicating "Other" which denotes non-European nationality. Although the survey was circulated around students within the BEST (Board of European Students of Technology) groups, 56% of respondents identified as female, which is not representative of the gender split within STEM programmes in general. The age of respondents ranged from under 18 to over 34, but 75% of the respondents were included within the 20-24 (inclusive) age bracket. A range of disciplines of study were included, made up of 25% from computer science, 25% other and the remainder from the main branches of engineering disciplines, maths and science. Students were quite evenly spread from first year to sixth year, with the majority of respondents in third or fourth year.

As this study has a quantitative approach the data will be analysed using statistical methods such as percentages, averages, and correlations to show the diversity of students' perceptions of educational and pedagogical approaches.

4 RESULTS

4.1 Teaching Approaches

In the survey students evaluated the proportion of different teaching approaches used in their degree programme. The four teaching approaches offered for selection included: (1) the proportion of lectures in large groups, (2) small group teaching, (3) laboratory work and (4) project work.

In the survey, the response options were presented as %-categories, divided into 11 response options. In the analysis, the response options were re-coded into new categories to indicate more clearly the students' evaluations. The responses in the categories 70-80% and above were combined. The results of this category is presented in the Table 1.

Although in the survey, students were able to select the proportions within 10% graduations, for simplicity, the responses are presented here by considering how many students reported the percentage of their studies in each of these teaching approaches as 70-80% or more. So, for example, responses were counted where a student indicated that at least 70% of their programme was made up of lecturing in large groups, or teaching in small groups, or so on.

Table 1. Percentage of respondents indicating that at least 70% of their studies use each teaching approach (Response categories 70-80% and above combined).

Teaching approach	Number of respondents (n)	%
Lectures in large groups	26	23.0
Teaching in small groups	8	7.1
Lab exercises	3	2.7
Project work	8	7.1

23.0% (n=26) of the respondents indicated that they have 70% or more of their studies as lectures in large groups. This can be considered as a large amount especially as the majority of the respondents were 3rd and 4th year students. At the end phase of an engineering programme, learning should happen mainly in real learning environments instead of lectures in large groups.

7.1% (n=8) of the respondents indicated that 70% or more of their study programme is teaching in small groups. Again, this is a small number especially considering the study phase of the respondents. This is also aligned with the responses connected to lectures in large groups.

2.7% (n=3) of the respondents said they have 70% or more of their study programme as laboratory exercises. Conversely, 9.7% (n=11) said they do not have laboratory exercises at all in their studies. This is an alarming result in a STEM discipline where it is well known that students benefit from laboratory work in applying theory into practice.

7.1% (n=8) of the respondents indicated that project work made up 70% or more of their studies, which is a surprisingly small number again, considering STEM as the discipline and especially when project work is understood to be a good pedagogical choice and the main teaching approach of some universities. 4.4% (n=5) said they do not have project work at all in their studies. STEM professionals work typically in projects in industry which attests that students should have project work learning environments and experiences in their studies.

Overall, in relation to teaching approaches, the respondents typically had lectures in large groups compared with small group teaching, laboratory work and project work as indicated in Figure 1.

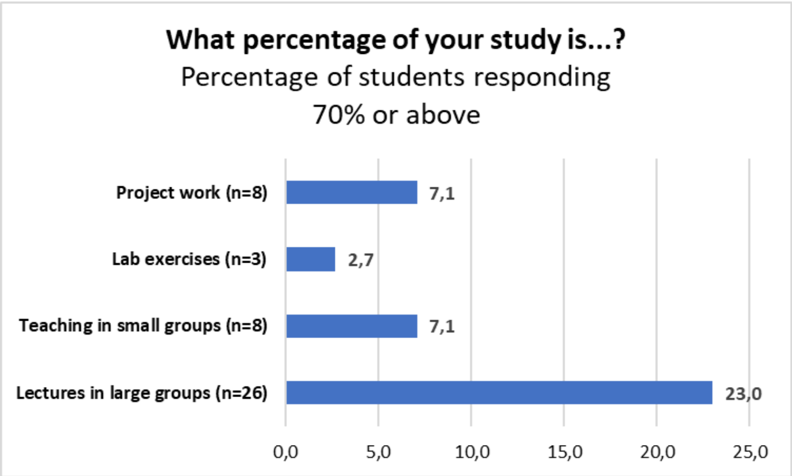

Fig. 1. Percentage of students responding that at least 70% of their studies is in each mode of learning

4.2 Study Projects

In relation to study projects, the time frame of a study project typically lasted for 1-3 weeks (mode). This category represented 25.9% (n=29) of the respondents. This can be considered as a short time period from the perspective of the development of expertise. The short time period then requires that separate projects in different modules are pedagogically aligned to support the overall learning objectives and development of expertise of the students.

The survey also collected information in relation to the percentage of projects undertaken in collaboration with industry. 48.1% (n=52) of the respondents indicated that they do not have projects in collaboration with industry/business at all (Fig. 2). This is a confounding finding for a STEM survey, especially considering engineering as a discipline. It is evident from prior research, contemporary theories of learning and their pedagogical implications that STEM and engineering education benefit from a close connection to real learning environments in the form of industry collaboration.

4.3 Impact of Teaching Approaches

The final question asked students about attendance and how often they skip a class because of the way it is taught. Overall, 90.7% (n=92) of the respondents indicated that they skip at least some learning activities because of the way they are taught (Fig. 3). In fact, 65.7% (n=71) respondents indicated that they skip up to 40% of classes as a result of the way they were taught.

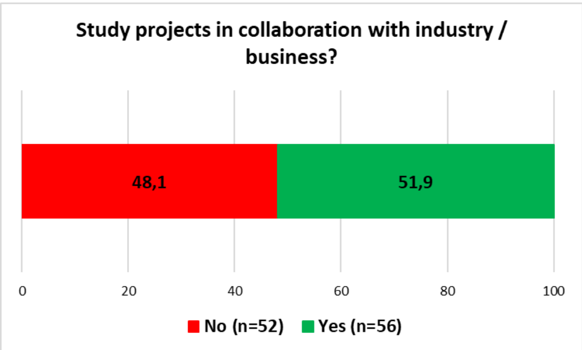

Fig. 2. Extent of Collaboration with industry

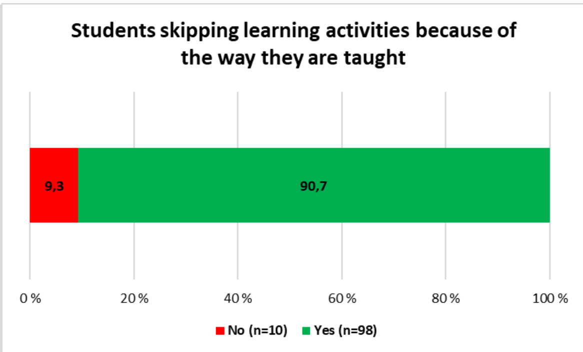

Fig. 3. Percentage of students who skip class

5 DISCUSSION AND CONCLUSION

This study sought to investigate students' perceptions of the different teaching structures and teaching practices and their resulting impact. It is clear that there is a diverse range of practices across Universities in Europe, but what is surprising is that although it is well known that small group and laboratory work are effective teaching practices, 23% of respondents still noted that they have at least 70% of their teaching in lectures in large groups. This is particularly concerning as the majority of respondents were in the latter years of their programmes (3rd and 4th year).

Perhaps more concerning still is that despite an acknowledgement in the education literature about the importance of real life projects and industry collaboration, 48.1% of respondents have no industry project collaboration at all.

However, the most illuminating aspect of this study was the finding that 90.7% of respondents indicated that they choose to skip a particular class because of the way is it taught. This is a wake up call to engineering and STEM educators to show the direct impact that their teaching approach has on student engagement not only in the classroom, but in bringing the students to the classroom in the first place.

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