The role of educational technology and learning spaces in electrical engineering education – a case study at Aalto University School of Electrical Engineering

Keltikangas, K. [1]
Educational Developer
Aalto University School of Electrical Engineering
Espoo, Finland

Hänninen, J.J.
Postdoctoral researcher
Aalto University School of Electrical Engineering
Espoo, Finland

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INTRODUCTION

Students of engineering are increasingly using technology in their life. Most of the first-year students have their own laptops when entering university. The capabilities of the students' mobile phones can be far better than of the academic staff. Students are connected to the internet with their equipment wherever they are. In addition, the generations who enter university in the next years are very talented in using different types of social media and internet services since their early childhood.

However, engineering education and its curriculum design is undoubtedly at least one step behind the students' current state. The technology used by the students in various spaces–not only in formal teaching ones–should be taken into account and its opportunities integrated into engineering education. At present, the current spaces used in teaching are often old-fashioned lecture theatres not equipped with state-of-the-art technology. The academic faculty does not use sufficiently mobile and online learning as an option when developing their courses.

A case study (n=236) was completed at Aalto University School of Electrical Engineering (Aalto ELEC) on how much engineering students use technology in their formal and informal learning. The survey covered the spaces used for learning as well. The results will gain insight into the students' thinking and will help teachers in the curriculum design. The results will also help the campus development managers in planning the renovation of the School's teaching spaces to support modern ways of learning.

1 GENERAL

Environment and space and have a significant role in teaching and learning [1, 2, 3]. The concept of learning environment in this study is defined as any space where teaching or learning, either formal or informal is taking place at a university campus. Furthermore, it means possible tools of information and communication technology (ICT) used in teaching, e.g. computer software like MATLAB, or electrical voting systems, such as clickers, or simply basic PowerPoint slide shows. It also consists of basic, preliminary things, for instance proper lighting, or air conditioning, in space infrastructure which ought to be functioning when teaching takes place.

Engineering education is facing many changes. New students entering university have used various forms of learning technology in their learning in prior school stages. New generations which enter higher education, are increasingly digital natives with good virtual networking skills and very well acquainted with various forms of social media [4]. They are typically growing up using their mobile

[1] Corresponding Author

phones and various applications for that. However, the teaching faculty and the spaces used in engineering education are not sufficiently prepared for the new students' way of using technology. Quite often, teachers in electrical engineering are still connected to the world in which they studied themselves some twenty or more years ago. Furthermore, university campuses, in particular formal learning environments, have largely remained unchanged although engineering education has increasingly adapted student-centred and flexible learning approaches. [5]

2 RESEARCH AIMS

The purpose of this paper is to increase understanding on the role of technology and learning spaces in electrical engineering. The case study was completed at Aalto University School of Electrical Engineering (Aalto ELEC). The sample group consists of 236 electrical engineering students (both Bachelor and Master level) who replied to a questionnaire.

1. How much do electrical engineering students use learning technologies in their formal and in formal learning?

2. What is the role of educational technology and spaces in learning electrical engineering?

3. What are the student-perceived benefits and hindrances of contact teaching (lectures, exercise classes, etc.)?

This paper contributes to engineering education design, in particular curriculum design. Likewise, it contributes to the pedagogical education and development in engineering education.

3 DATA COLLECTION AND RESEARCH METHODS

3.1 Data collection

The data for the study were collected with a questionnaire distributed in paper form to engineering students at Aalto ELEC. The questionnaire consisted of three quantitative questions with separate sub-items on the technology and spaces used learning. In addition, it had six open-ended questions on individual learning. Students in various courses (altogether 11) were asked to fill in the questionnaire anonymously during lectures. The collection of the data took place in the spring term 2013, and the entire number of filled-in questionnaires received was 236. The questionnaire was developed in and has been used by the Helsinki University Faculty of Behavioural Sciences.

3.2 Research methods

The data from the quantitative questions were processed with the Microsoft Excel programme. The average grades, standard deviations, and medians were calculated.

The open-ended answers were transcribed into contextual data. Overall amount of data was 56 pages of contextual data. Recurring themes were identified through an iterative process from the transcribed data. Quotations representing and illustrating themes found were selected from the interviews. The data were analysed with the thematic analysis approach [6]. The researchers went through the data several times and formed categories and common phenomena of the data. Both researchers had acquired teaching experience at Aalto ELEC for several years.

4 FINDINGS

4.1 Quantitative findings

In general, students still study at lecture halls, libraries, or in spaces which are categorised as "formal learning spaces" *(Table 1).* At the time of the questionnaire, most students used their own computers with their studies and not much, for instance, tablet devices, or mobile phones for completing their tasks *(Table 2.).*

Table 1. The study places in order of preference (1 = rarely, 6 = frequently used)

Place	average	standard deviation	median
In campus			

computer class	3.69	1.37	4
lecture hall	3.68	1.59	4
exercise class	3.50	1.48	4
group work space	2.84	1.48	3
library	2.29	1.58	2
lobby or corridor	2.23	1.26	2
cafeteria	1.21	0.54	1
Off campus			
home or with friends	5.31	1.01	6
elsewhere (most popular: at work, average 4.60)	3.04	1.82	3
diverse (vehicle, waiting room, etc.)	2.04	1.14	2
library	1.61	1.15	1
café	1.24	0.58	1

Table 2. The technical devices in order of preference (1 = rarely, 6 = frequently used)

Device	average	standard deviation	median
own laptop computer	4.37	1.85	5
own desktop computer	3.74	2.15	5
other (most popular: calculator, average 4.22)	3.72	1.93	4
computer classroom (school) computer	3.41	1.34	3
smartphone	2.85	1.68	3
tablet device	1.73	1.53	1

4.2 Qualitative findings

Students in the sample group answered to the open-ended questions about positive or negative experiences on learning. The majority of the students had straightforward replied that one of the most negative experiences had been such a teacher or a professor who did not teach or have any interaction but was reading his/her Windows Power Point slides as a “talking head”. Furthermore, slides consisting of too much text, unclear material, or too many equations were found as negative sides in lecture type of teaching.

Most students gave positive feedback for such teaching faculty who had designed interactive, interesting lectures, for instance, using electronic voting devices (“clickers”), or other type interactive learning technologies. Electric voting devices had helped their learning, for instance, when teacher had used conceptual tests on a physics bachelor level course. However, learning technology did not play a major role in their learning process. The majority of the students mentioned that most significant issues in teaching electrical engineering were:

- integrating theory well into practice
- versatile teaching
- good calculation exercises with the possibility to get help from the assistants; learning-by-doing
- enthusiasm or good motivation of the teaching faculty
- good pedagogical skills for the teaching faculty

A striking observation was that the possibility for interaction between students and teachers during contact teaching—with the exception of exercise class assistance—was seldom mentioned in the data. However, “lectures” and “lecturers” were common words in the answers considering hindrances

of contact teaching. Some students complained about noise (other students' conversations) during lectures.

However, learning technology and spaces were intertwined into the data. The poor condition of the Aalto ELEC building was commented much. Students were asked to offer ideas for renewing the physical building, or the technology used in the formal and informal spaces used in teaching. Quite a few students had suggestions about independent informal learning spaces for group working, or performing calculations in a group. But, however, due to the poor condition of the School building, students were mainly asking for better air conditioning in the lecture theatres, or improvement for the lighting in the classes and lecture halls. Also, more computer classrooms and printers were requested. Some special electrical engineering software packages are not available for the students' own computers via campus licenses and, thus, access to university-administered computers is still necessary. One of the challenges of electrical engineering education is the presentation of the subject matter itself, which is mathematical and visual—containing circuit diagrams and graphs—and therefore defies easy computer input and automated processing of, for example, exercise answers. Few, yet some, students dared to wish for the use of computers in submitting exercise answers. Systems like STACK (System for Teaching, and Assessment using a Computer algebra Kernel, [7]) exist, but they present an additional layer of work for both the student, namely learning the input language, and for the faculty in the form of an additional administrative task.

Both quantitative and qualitative results show that further research on the topic would be necessary. The speed of the technological development is high and if the data were collected in this phase (spring 2014), it can be assumed that at least the quantitative part would be different. Our suggestion is that universities in engineering education should increasingly support the use of various activating learning technologies and methods. Teachers have a very significant role when adapting new methods; they should particularly need additional resources to be able design larger and more fundamental changes into their courses. In everyday teaching they might lack at least sufficient time to perform more thorough course planning. Impacting this situation is rather much dependant on the prevailing educational management processes at each HEI. In addition, more knowledge of using different type of learning spaces, either formal or informal, should be available for curriculum design processes in electrical engineering. The mobile computing devices are the great uncharted territory in teaching: how can they be utilised for effective learning, beyond being just handy presentation platforms for lecture notes.

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