

Renewing a course structure can reduce the number of students to retake a course

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ABSTRACT: This study considers the impact of renewing a course structure on students' motivation to study through a course and their decreasing need to retake courses. Two different educational methods that have been used during the past ten years are introduced. The learning results and students' behaviour are compared in both methods. It was expected that there would be more passed grades in the courses under this study, when more activating teaching methods were in use. In particular, in this article, a count of accepted grades is under close examination, but also the rates of grades will also be considered in the future. Although the expectation of better results in a new course using a more activating method were high, the results were surprisingly positively.

Keywords: Renewing process, motivation, learning results

INTRODUCTION

This study concentrates on years 2008-2010, when old versions of the original lecture and examination-based courses in electronics were taught. A new version of the same courses have been in action in years 2014-2018. The old version of the Bachelor programme was also available in years 2011-2013, but detailed data were not collected during that time. In this study of two courses were introduced. Course I was offered in the autumn of each year and Course II in springs. Additionally, a revision of teaching methods and a motivation of students to participate more actively during a course are presented.

COURSES IN ELECTRONICS

Electronics has been taught at Aalto University (and its antecedent Helsinki University of Technology) for tens of years. Starting from 2005, two courses in electronics were included in a Bachelor programme in electrical engineering. Since, the first course, Course I, was a compulsory part of this Bachelor degree programme, only from time-to-time a few students from other Bachelor programmes were involved in it. The second course, Course II, was compulsory only for some of the students and few took it voluntarily.

Since 2014, Bachelor-level electronics still consists of two courses. The first course, Course I, is still a compulsory part of the electrical engineering Bachelor degree programme. It still has the same content and its main topics include amplifier models and frequency response, function of pn-diode and diode circuits, operational amplifier circuits and the effect of non-idealities, MOSFET transistor circuits, parasitic components of circuits and their effect on amplifiers' frequency response, the Miller effect and amplifier circuits with several transistors. The second course, Course II, is similarly a part of the same Bachelor degree programme, but compared to the earlier time, it is now compulsory. It focuses on noise and nonlinear distortion in amplifiers, feedback, stability and frequency compensation of amplifiers, filter and oscillator circuits, A/D and D/A converters, truth tables and POS and SOP forms, Karnaugh map, Boolean algebra, CMOS logic ports and state machines.

OLD AND NEW METHODS

Since the beginning of the time that electronics has been in degree programmes at Aalto University and Helsinki University of Technology, teachers have used lecture-based learning with practical sessions as an addition.

Neither lectures nor practicals have had any effect on grading. The whole evaluation process has based on two mid-term examinations during a course or one examination after a course. Above-mentioned teaching method was the most common at that time and neither students nor teaching personnel challenged that.

The Bachelor-level courses and the way of thinking affect how the students progress into engineers. It is a faculty member's responsibility to help students to become engineers. There are students who will manage to pass every course, even if the courses are organised and taught in a substandard way. In any case, engaging and motivating courses should be offered to help students to learn. However, for as long as there have been students, there have also been poorly organised courses. These problems have been shown in research by Baillie and Fitzgerald [1]. When observing results in the mentioned courses, a notable conclusion is how clearly less than half of the students managed to pass courses and how many of them retook examinations sometimes even two or more times. When thinking further about the situation, there has to be a more efficient teaching method to encourage and motivate students to participate more actively. This thinking led to an idea of what learning is.

By definition, learning can be described as a change in one's behaviour, A student, a learner, interacts with an experience and then learning occurs. Every new learned concept has a connection to the foundation of already known skills and learned knowledge. Mental representations or models are required [2].

Learning is not the only issue that matters when thinking of renewing a course. There are several issues to take care of when trying to create a successful course and a Bachelor programme at a university. Such unconnected things as type and location of a school or age of the students and the working staff adjust circumstances [3]. A supportive climate and cooperation with and among teachers has an effect on learning [4][5].

A huge renewing process on Bachelor-level study programmes started in 2013 and new courses were launched in September 2014. When renewing courses, motivational aspects were kept strongly in mind. Intrinsic and extrinsic reasons in motivation may lead to different kinds of result. In another study, when student groups studied the same material under different conditions of extrinsic and intrinsic motivation, it was shown that a lack of interest in the material made the experience harder for the students. It leads to an inefficient experience and lower level learning [6]. Before taking a long step to a different type of course, similar teaching methods and more activate studying methods were tested and encouraging results were achieved in 2012 [7].

Before starting the renewal process, it was understood that a grade itself is often an outer goal and not a reason for intrinsic motivation. Intrinsic motivation itself is defined as undertaking an activity for an inner reason and not for reaching an outer goal, like a grade. To reach the main target of intrinsic motivation one needs to compare intrinsic and extrinsic in contrast to each other. Extrinsic motivation cannot be seen as motivation that focuses on an interest in the work itself [8][9]. In this light, the new courses were designed to have smaller units and more varying study methods to support different kinds of learner.

The old courses had 12 two-hour lectures, and 12 practical sessions, also lasting two hours each, combined with students' own work, assumed to be more than 90 hours and an examination. It was assumed that students would participate, but lectures and exercise sessions did not produce any extra marks or were otherwise taken into account in grading. The only task effecting the grade was an examination. Students could not see their level of knowledge and an ability to apply their knowledge until in the examination. It is clear that students were not motivated to attend exercise sessions and fewer than half of the students attended lectures either. A low level of understanding may have been a surprise in the examination, and because students may not even have met other students in the same situation, they were lacking peer support. A laboratory course, which followed theoretical courses, was given in addition. Laboratory exercises were graded on a pass/fail scale only. This may have encouraged students to minimise their laboratory work.

Briefly, in this situation a lecture-based and examination-oriented teaching can be seen as not encouraging or pushing students towards deep learning, and does not support motivation to participate. Furthermore, when accepting students to test their level of learning and understanding in an examination as many times as they want, a working life-based model is not supported. A student may have a problem to estimate his/her own work contribution during a course, if the only result to estimate it appears in an examination after the course.

When mentioning active learning and active teaching methods, it is important to remember that a teacher cannot assume that students who have high achievement motivation would automatically reach higher grades. A teacher cannot assume either that intrinsically motivated students would perform better than students who are extrinsically motivated. Intrinsically motivated students are often expected to have deeper understanding and a lower grade would not discourage them. There is no explicit evidence of any of these expectations [10]. However, if it cannot be stated that there is a variety of student types correlating to types of motivation, it is still possible to measure how motivated students are [11][12].

It all culminates with the teacher's action, for example, on student-centred teaching and a variety of teaching methods [13], level of professionalism [14] and effectiveness [15][16]. A motivated and skilled teacher can offer more active and

practical teaching [17]. The target in this renewing process was to create courses when the workload would be shown transparently and various smaller tasks form the whole. Most likely, it is impossible to create a course that is suitable for every student. It can be assumed that some students do not prefer a course when continual attendance or weekly returned assignments are required. Nowadays, Bachelor degree programmes at Aalto University have been planned for full-time students and teachers expect them to study on campus.

A model of learning in electrical engineering is shown in Figure 1. Methods of thinking and practising, lectures and other materials, laboratory assignments and simulations, other assignments, experiences and assessment are mentioned. Here one important factor is tutorials and support from other students. This model expresses that one cannot assume learning to take place only in lecture halls or when studying alone. Social influences and several learning methods are important [18].

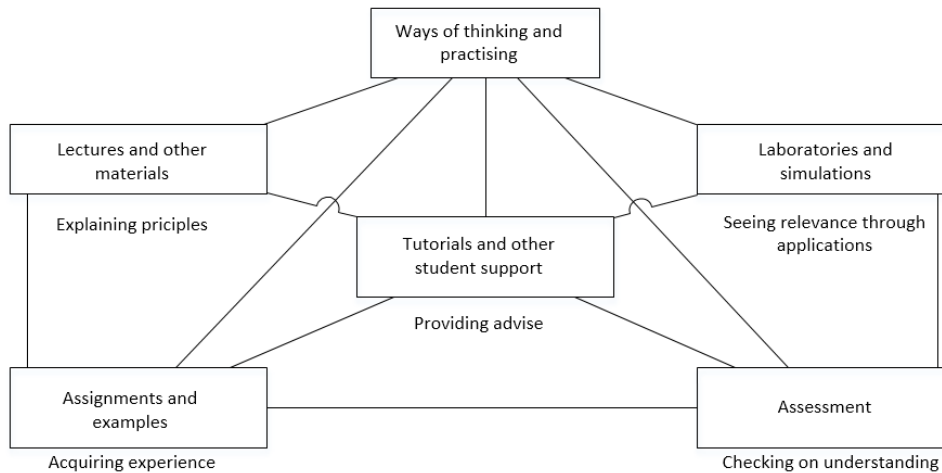


Figure 1: The teaching-learning environment in electrical engineering.

New courses have a wide variety of teaching and learning methods, but the content itself is about the same. Because the course content itself has not changed, the level of understanding and requirements from the students at the end of a course has been maintained. Now, the new courses consist of ten two-hour lectures and ten practical sessions, also two hours each, two laboratory exercises, of four-hour duration each, four simulation exercises, two hours each, and two mid-term or one examination depending on the students' preference. Every lecture has a short lecture examination at the end. Students' own work is assumed to take 52 hours. It has been under discussion that the volume of energy and time connected to productive activities predicts a level of personal development and learning [19]. Consequently, the main target was to produce enough exercise materials and ways to learn and test things.

Evaluation in the new courses is not based on examination only, but an examination or two mid-terms have a 50% importance in a grade. Other activities produce the other 50%: laboratory assignments 20%, lecture examination and feedback 10% together, active participation to in-class tutorials 10% and simulations 10%. Students' own work outside contact teaching hours is still considerable, but lower than earlier. Few non-attendances during a course do not cause problems and have hardly any effect on a grade. Skipping a whole laboratory assignment decreases an opportunity to achieve very good marks, but missing one or two lectures or theoretical classes will not. Another target was to create a course for students who participate more actively.

RESULTS

When comparing the number of students taking examinations and registered in a course, it can be noticed that most of the students did not even try to pass the course. Also, there were plenty of students trying or, as can be said, taking one's chance in the course. One of the motivational aspects to arrange these courses in a new way was that it is more efficient and simpler to estimate the amount of students acting in course in practice. As simple as it may sound, even making lecture hall reservations can cause problems if the number of students in a lecture is unknown.

As mentioned earlier, Course I was compulsory in the electrical engineering degree programme, but also to a variable number of students in other Bachelor degree programmes. Starting from 2014, this course has been limited to students in electrical engineering and other students taking the course can be accepted only if needed. The course was withdrawn from other degree programmes. Furthermore, the degree programme in electrical engineering was clarified and now all the students taking Course I are also taking Course II. Because there are still about 10% students joining Course I from outside of the degree programme, Course II has slightly smaller numbers of students.

The Bachelor programme in electrical engineering has an intake of 100 students per year. That is the number of students a teacher should meet during the course at the beginning of their second year in a university. As shown in Figure 2, increasingly more than 100 students were starting Course I before the autumn semester in 2014. As can be expected,

some older students still appeared among the number of participants in the Bachelor degree programme and they appeared in the statistics the first few years when the new course was running. Since then, the situation has stabilised and there are only a few more than 100 students, as expected.

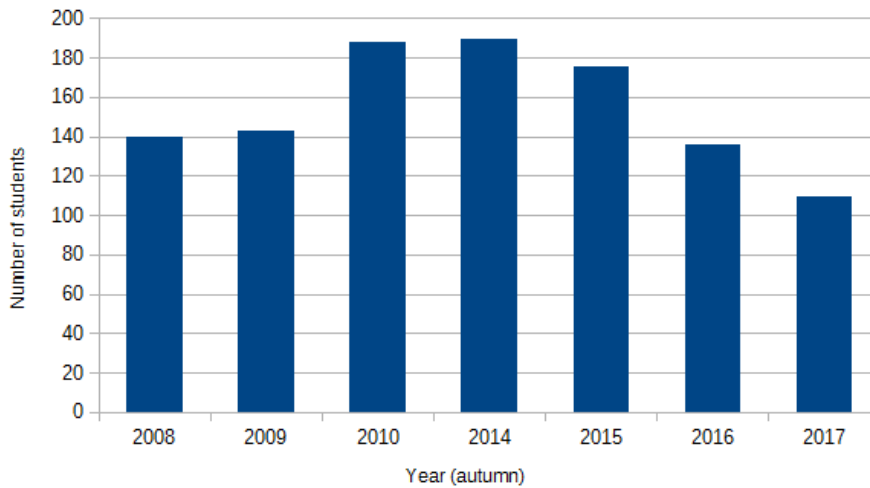


Figure 2: Number of students starting Course I.

According to the collected data, the number of students starting Course I has been stabilised as expected with a result that also the number of students passing the course stabilised. The percentage of students passing the course increased outstandingly after the new courses were launched, as shown in Figure 3. Now, it is on an acceptable level, and over 70% of the students do pass the course. This statistic presents the situation after the two mid-terms before the first examination has been taken. Nowadays, only some of the students choose to take an examination and have not joined the mid-terms.

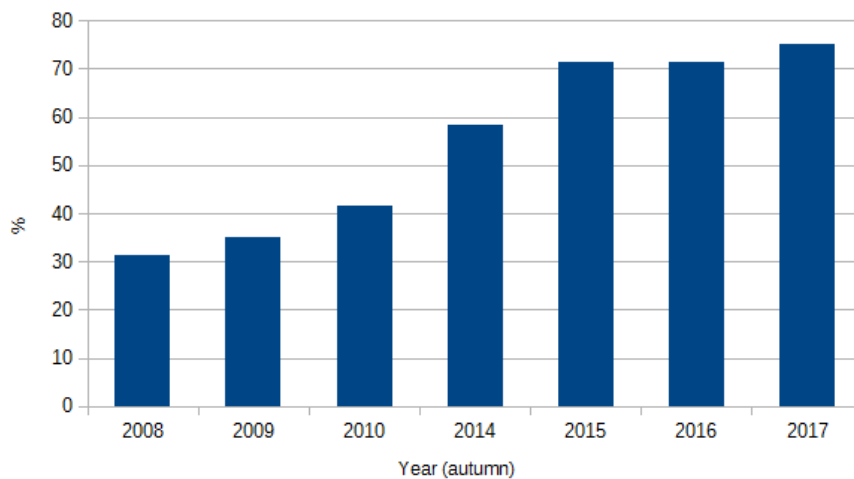


Figure 3: Percentage of students passing Course I.

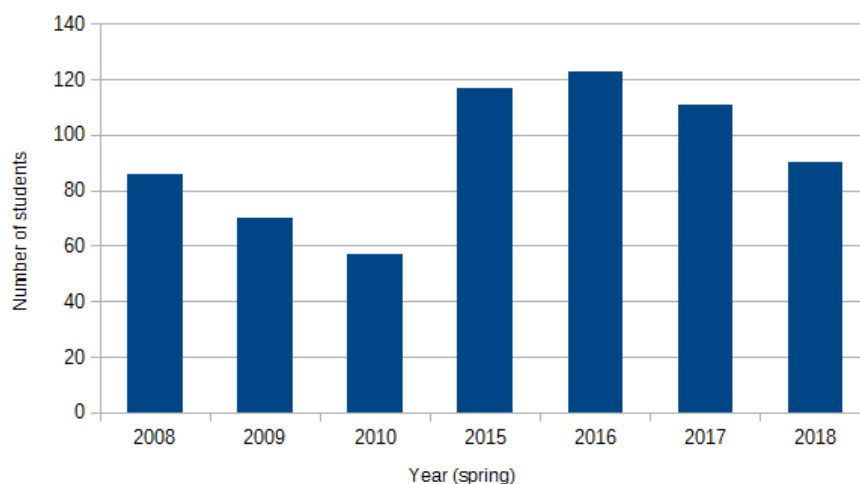


Figure 4: Number of students starting Course II.

Different problems were faced in the old Course II, but it was assumed that the changes in Course I would have an effect on Course II. After the renewing process in the Bachelor degree programme, there has been roughly the same number of students starting both courses. As shown in Figure 4, some of the students continued from Course I to Course II in the old degree programme. Since 2015, both courses have had about the same number of students. At the beginning and a year after the new courses started, the same phenomenon existed in Course II and some older students still appeared. Now the situation is as stable as it is in Course I. It can be noticed that the percentage of students passing Course II is also increasing. The situation in Course II was not as alarming as it was in Course I that Figure 5 also demonstrates.

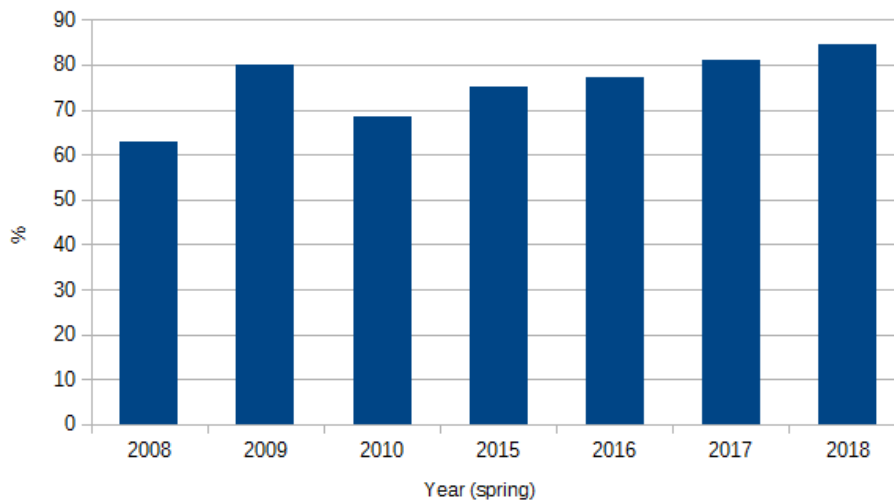


Figure 5: Percentage of students passing Course II.

CONCLUSIONS

Two courses have been taught and evaluated in two ways. Differences in results have been found and they showed that remarkable differences in learning results can occur when studying in a course is more controlled, but also more consistent week after week. There is no need to ask, if the changes were useful, because the results have improved significantly.

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BIOGRAPHY



Sanna Heikkinen graduated with a Master of Electrical Engineering from Helsinki University of Technology, Espoo, Finland, in 2007. Ms Heikkinen has been teaching and developing courses in the School of Electrical Engineering at Aalto University, and visited Riga Technical University, Riga, Latvia, and Tallinn University of Technology, Tallinn, Estonia, as part of her research. Her research focuses on motivation and learning processes in technical fields in higher engineering education.