

# Activating Teaching for Quality Learning

Vitaliy Zhurbenko

Technical University of Denmark  
Kgs. Lyngby, Denmark  
vz@elektro.dtu.dk

**Abstract**—Activating teaching is an educational concept which is based on active participation of students in the study process. It is becoming an alternative to more typical approach where the teacher will just lecture and the students will take notes. The study described in this paper considers student activating teaching methods focusing on those based on knowledge dissemination. The practical aspects of the implemented teaching method are considered, and employed assessment methods and tools are discussed.

**Keywords**—activating teaching methods; formative assessment; rapid assessment tools.

## I. INTRODUCTION

The Danish Government has introduced new policy lines partly in response to the international crisis. Proactive steps have been taken in different areas including education. As a result, the Government has set new specific goals for higher education including the following [1]:

- at least 50 percent of a youth cohort are to have a higher education in 2015;

- the quality of short cycle and medium cycle higher education programmes and university education programmes must match the best in the world;

- young people are to be encouraged to begin higher education programmes earlier, and the education programmes are to be organised so as to minimise delay.

In short, the aim is to educate more students and do so faster, while keeping the quality of education high. This puts high pressure on universities and motivates development and implementation of activating teaching methods, which are believed to be more effective than traditional methods.

The study presented in this work is dedicated to practical aspects of student activation techniques. The paper starts with a short introduction to the existing activating teaching methods. The main focus of the following Sections is on the practical implementation and analysis of the teaching method based on self-study and knowledge dissemination.

## II. ACTIVATING TEACHING METHODS

It was indicated by several studies [2] that the following learner activities facilitate material/thing learning, listed in order of increasing learning efficiency: reading, listening, watching, talking over with others, using and doing in real life, teaching someone else. According to these studies, teaching someone is one of the most efficient activities. The activating teaching method described in this work is based on this

principle, actively engaging students in *knowledge dissemination*. The method involves self-study a part of the material. The self-study is then followed by knowledge dissemination in a form of student presentation in front of their fellow students, and a discussion. In this way students are encouraged to actively participate in the teaching session. One, however, could foresee several challenges to this method implementation. First, not all students are good presenters. That might prevent the rest of the students from efficient study of the material. Second, it is more difficult to control the flow of the teaching session, since it is becoming more spontaneous. It should also be noted that the method is mostly suitable for relatively small classes.

In addition to this approach, there are several other teaching methods, which can be used for activation of students [3]. *Problem-based learning* - the students learn by relating their previous knowledge and the new knowledge acquired from the curricula to a given problem or case. *Learning by projects* - the teacher outlines project ideas from which each group of students can define their project. In this approach, the outcome includes a product. *Learning by inquiry* is a research based approach, which gives students a life-long insight into research as a method to create new knowledge and learning. The students must find, evaluate, and use the sources of information available for the subject in question. *Spiral learning* is based on repetition and feedback. The students work with the subject in increasingly advanced ways. *Learning by step-by-step theory application* - the teacher selects one case that covers all the major topics in the curriculum, and divides it into weekly group assignments whose solutions will lead towards the solution of the overall case. *Flexible Learning and E-learning* which supports different learning styles and different living conditions that the students may have.

The following Sections are focused on practical implementation of the first teaching method based on knowledge dissemination.

## III. PRACTICAL IMPLEMENTATION OF THE METHOD

The method was implemented in the 31420 Microwave Techniques course, which is a 10 ECTS points course and recommended at the eighth semester. The teaching sequence is implemented in the following way. During the first teaching session, a pre-test of students is conducted. The main goal of the pre-test is to provide a background for final adjustments in the course content and teaching approach. The pre-test consists of two main parts. The purpose of the first part is to

identify students' background, make them aware of different learning approaches, as well as to make them reflect on what learning approach is most suitable and efficient for them. The second part is more technical and dedicated to the basic knowledge the students suppose to possess before starting the course. To evaluate the second part of the pre-test, a peer review is used where students have to assess the answers given by the fellow students. The purpose of this evaluation is to facilitate discussion between the students and to save teachers' time on processing the received answers. This second part is designed with focus on conceptual understanding of the relevant basics.

Analyzing the results of the pre-test, it was found that

-basically, all participating students had the required background;

-the course participants are highly motivated;

-the students indicated that solving tutorial problems was the most efficient method of learning for them.

The first and second conclusions have confirmed suitability of the chosen teaching method, since it requires active participation of the students, which is only possible having highly motivated participants with an appropriate background.

Considering the third conclusion it was decided that group tutorials should remain in the course and they were even extended in comparison to the previous year. That was the main change in the original teaching plan, which originated from the analysis of the pre-test.

During the first teaching session, the plan for the following discussion sessions is announced (that mainly contains the list of themes to be covered) and the class is split in groups of two to three students. The students were allowed to form the groups themselves. Each group is allowed to choose a specific theme they should prepare from the given list. Giving this freedom of choice is the first indication to students, that they are self responsible for the coming teaching sessions. This arrangement also contributed to the development of general skills among the students, such as self-management and communication.

The teacher starts the following teaching session with a short introductory talk emphasizing the core elements of the themes to discuss. That follows by student presentations. Each student presentation is finalized by questions from the audience and a discussion. Each presentation and discussion are then summarized by the teacher (in order to make sure that all the key aspects are covered in the presentation) and finalized by a formative assessment. The assessment is conducted in a form of short quizzes.

The quizzes are designed mainly to identify misconceptions and, partially, to complement the group tutorials. This was done by combining two formats of assessment: multiple-choice and more open-ended format. The reason for that blending was the fact that there is no conclusive data in the literature defining which format provides lowest test anxiety measures and most positive attitudes towards the assessment. Some groups of students prefer multiple-choice format (which is also easier to implement using electronic assessment tools),

whether some other groups prefer more open-ended format [6].

Since the implemented here teaching method assumes a considerable number of quizzes (at each discussion session), electronic tools for a rapid student assessment should be used where it is possible.

#### IV. ANALYSIS OF THE APPLIED TEACHING AND ASSESSMENT METHODS

There are several challenges to the implementation of this teaching method. First, the students are in the process of developing their presenting skills. If the quality of presentation is not high enough, this might prevent fellow students from efficient study of the material. In order to overcome this problem, teachers' introductory and summarizing talks should be used, where important aspects of the themes are emphasized. The following aroused discussions are also helpful in this respect. They provide an opportunity to identify weak points, clarify them and take appropriate actions. It is during the following discussions that the process of learning takes place for those who did not get the material from the presentation. It can be noted that students actively participated in the discussions. It seems like students are less reluctant to ask their fellow students if something was not clear, or if they wanted to know more about the presented topic.

Second concern is that it is more difficult to control the flow of such a teaching session in comparison to the traditional lecturing. This is due to the fact that the teaching session is more spontaneous. It should also be noted that the suggested teaching method is mostly suitable for relatively small classes of up to twenty students, as it was the case in this study.

Third, there is a concern regarding the time planning, since it is difficult to estimate how much time it would take for students to present their theme and time for completing each test. Nevertheless, the teaching sessions went smoothly, almost by the plan. Some of the quizzes, however, have been slightly shortened.

It should be noted, that the applied teaching method relies completely on active participation of the students. Therefore it was important that each group shows up and prepares the given theme. That, however, went as it was planned, and there were no groups which would not show up, or be unprepared. On the contrary, all students have shown high activity, and it was obvious that every presenting group put maximum efforts to present their topic in the best manner. Many groups used sources beyond the proposed teaching material. Some of the concepts have been explained using animated examples which they found in Internet.

#### V. DISCUSSION OF THE ASSESSMENT AND LEARNING OUTCOME

There are, in general, two forms of assessment: formative and summative. Above, the formative assessment has mainly been covered, which is an important instrument in activating teaching. The final examination, which constitutes the main part of the summative assessment in this course, is based on

examination problems which are designed to cover all learning objectives according to the constructive alignment concept. The main focus in this work is on the formative assessment (or formative feedback, as it is referred to in [2]). Providing feedback during learning is emphasized in [2] as the most powerful enhancement to learning. As it was described above, the formative assessment is performed in a form of quizzes. The content of each quiz is designed to cover the learning objective for the corresponding teaching session. In its turn, the learning objectives for each teaching session are aligned with overall learning objectives of the course. In this way, the alignment of the assessment with the learning objectives of the course can be ensured.

Here is an example of such an alignment. One of the course learning objectives are to *be able to analyze microwave circuits containing transmission lines*. Based on this objective, the objectives for a particular teaching session are formulated as follows: *being able to*

- analyze voltage distribution on a transmission line,
- calculate propagation parameters for a transmission line with different loads.

These objectives then serve as an input during formulation of the questions in the assessment:

- find the magnitude of the reflection coefficient for shorted or open transmission line.
- find the reflection coefficient for a transmission line loaded with  $Z_0$  ( $Z_0$  is the characteristic impedance of the line).
- write an equation for standing wave ratio, *VSWR*, in terms of maximum and minimum voltages.
- find *SWR* for shorted or open transmission line.

In this manner, the assessment is constructed to align with the course learning objectives.

Often assessments (every teaching session) allow continuous monitoring of students' learning outcome, and provide possibilities to adjust the course content, if necessary. The results of the assessment indicated that the most part of the students achieved the learning objectives.

## VI. ANALYSIS OF THE EVALUATION BY THE STUDENTS

In order to assess the quality of the provided teaching, a student evaluation of teaching has been conducted using a course experience questionnaire developed by the Learning Lab DTU. The questions are divided in five categories. Below, a detailed analysis of each category is provided.

*Good teaching scale* category showed the mean value of 4.3 out of 5 with the lowest scores for feedback. The problem of providing appropriate feedback is generally strongly related to the number of students in the class. The more students we have the less time in average per student we have to respond on their requests and give continuous feedback on their progress. We have seen from [2] that formative feedback is an important constituent of effective teaching. The student-teacher interaction can be optimized, but there are obvious limits to the number of students that can be handled appropriately. Fortunately, the number of students in this course was relatively small, and the achieved mean was still

way above the average of 3. For larger classes I foresee this as a much bigger problem.

*Clear goals and standards* category showed the mean value of 3.86 out of 5. The problem here is associated with the limited feedback, as described above. More feedback would provide a better idea about the expected standard of work, but, as it was already mentioned, this problem is related to the available resources.

*Appropriate workload* category showed the mean value of 4.1. All questions in this category showed approximately the same score. The results indicate that the workload given is perceived to be manageable.

*Generic skills* category showed the lowest among the other categories mean value of 3,05. This is mainly due to the fact that the development of the generic skills is not a part of the learning objectives of the course. Therefore the teaching activities were not focused on this outcome even though these skills are very important for effective learning.

*Motivation* category showed the mean value of 4.07. The dispersion of the scores in this category was low. The achieved mean value indicates that, in general, the course was motivating. That might be the result of introducing problems which are close to the real world examples. That might have stimulated the interest in the field of study. The relation of the topics to students' background knowledge as well as possible lines of study have been outlined which might have stimulated the enthusiasm for further learning. The fact that in advanced courses, like the one here, we usually deal with more mature students having high self awareness, as it was confirmed by pre-test results, contributes to the high score in this category as well. The students in this course were highly motivated and willing to actively participate in the course from the beginning. So, in this context, the task of the teacher is to maintain the high level of motivation. In order to do that, the teacher should understand the main source of motivation.

*Information technology* (IT) category showed the mean value of 3.64. IT was used in this course for three main purposes:

- course management and planning;
- rapid student assessment;
- visualization of the teaching material.

The course management and planning was done using available at the Technical University of Denmark (DTU) web-based course management system.

The visualization of teaching material mainly was done using animated examples and interactive JavaScript applications which should aid in learning basic concepts. The reason that IT category did not achieve a better score is that the web-based rapid student assessment tools were used here for the first time, and the implementation was not as smooth and optimal, as students might have expected.

## VII. ASSESSMENT TOOLS

Currently there are many tools for rapid student assessment. Here the focus is on those which involve electronic means, and are web-based [4] or use terminals, "clickers" [5]. The second option is robust, but comparatively expensive. Since

all students typically possess electronic devices with Internet access, a web-based assessment system (socrative.com) is chosen here. This electronic tool is an attractive alternative to the traditional assessment methods (where students have to deliver their answers in paper) due to rapid assessment, which saves time for manual processing of the results. In addition, students are usually very open to new technologies and willing to use them in their study, as it is indicated by the data presented in Fig. 1. Such an electronic assessment method also allows for a rapid feedback on students' performance, which is highly valued by the students.

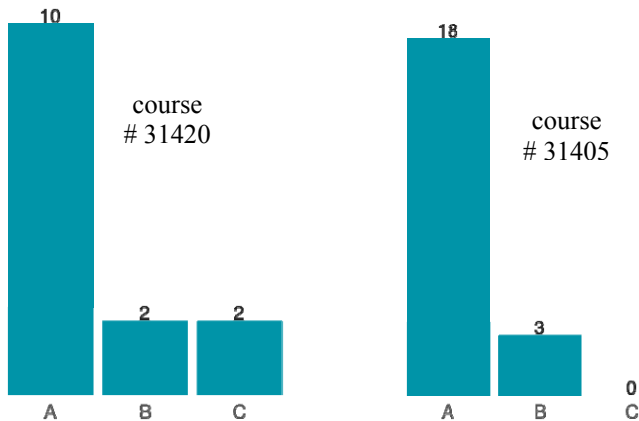


Fig. 1. Evaluation results. Students prefer (A) electronic form of evaluation; (B) evaluation delivered in paper; (C) have no preferences. The results have been collected using a web-based student response system [4].

Here students have been asked about their preferences regarding the form of the assessment. As one can see, most of them liked electronic form of evaluation.

### VIII. IMPROVEMENTS FOR THE FUTURE

The discussed here method is implemented in this course for the first time. After analysing the method, the following changes are suggested for consideration next year:

- Modify the pre-test and include questions which would allow to identify and monitor changes in students' conceptual understanding during the course.
- Implement the most part of the formative assessment in electronic form. Avoid off-line in paper evaluations where it is possible. This would allow to provide feedback much faster than it is possible with the traditional assessment forms. This should also considerably reduce the time for processing and statistics. The implementation of rapid assessment tools is considered as a promising way to optimize student-teacher interaction.
- Consider development of generic skills. Already in the presented implementation, where students had to disseminate the acquired knowledge via oral presentations, students developed communication and graphics skills. The development of generic skills can be included in the learning objectives and then pursued more actively in the course.

Provide students with a feedback not only on their professional skills but also on their generic skills.

### IX. CONCLUSIONS

The question of using self study and dissemination as a teaching method was considered in this work. As it was found, the implemented here teaching method can be very effective if carefully planned. The method is designed to activate the students while they play a role of teachers for the fellow students. The remaining students are then activated through discussions. The discussions also provided opportunity to identify weak points in learning and take appropriate actions. Such a student-focused teaching approach has characteristics in common with a student's deep approach to learning, which is considered more effective [6], than the teacher-focused strategies.

The presented here method works best when accompanied by a continuous formative assessment. The assessment was used here as an additional activating instrument. Using different activation methods, which encouraged students to study, enhanced learning. They require more work from the student but also more work from the teacher, both of whom have limited time for teaching and learning. This makes careful time and resource planning important. Thus, there will always be a trade-off between the amount of used teaching time per student and efficiency.

Feedback is also an important issue to solve, because feedback is vital to students but it requires time resources from the teacher. Two solutions to this problem have been implemented in this study, which allowed optimization of student-teacher interaction. First, it was shown that the continuous formative feedback is conveniently handled using IT capabilities. Second, using peer assessment as a part of the studying process is also efficient and helpful. Of course, teacher feedback will always be needed, but it could be used in a more directed manner.

### ACKNOWLEDGEMENTS

I would like to thank Claus Thorp Hansen, Thomas Bolander, Pernille Hammar Andersson from the Learning Lab DTU, and my colleagues at the Electrical Engineering Department for fruitful discussions. I also want to express my gratitude to my students who participated in this study.

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