Integration of Students in the Teaching Process

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Abstract - One of the challenges in modern engineering education is the demand for lectures of high quality, where the subject is presented in an interesting and engaging way. By integrating the students into the teaching process, time for preparation can be reduced with up to 75%. Lectures can be made more effective and interesting by using a combination of Power Point presentations, the blackboard, exercises, posing questions to the students, and student presentations. Using Power Point presentations to create on-line learning material can compensate for the lack of suitable text-books in certain engineering disciplines.

Index Terms - Engineering software, pedagogy, software tools, student participation.

INTRODUCTION

Since ancient Greek times, lectures have been a standard method for imparting information to a group of students. This is still a major way of communication in the teaching process at the Faculty of Engineering, Oslo University College (OUC). The lectures are not compulsory, and if the quality is low, students simply decide to stay away.

The traditional standard format for lectures is a 40 minutes teacher monologue. Research has shown that this kind of teaching has a number of weaknesses, and there is need for supplement to the lecture in the form of student activities [1] [4] [10]. Human beings are not able to keep up attention for more than around 15 minutes before concentration falls dramatically [1]. For this reason, it is necessary to vary the lecture activities. The inspiration for this paper is based on the authors’ teaching experience on both bachelor and master level, and the ideas of J. Biggs, described in “Enriching large-class teaching” [1].

This paper describes the project “Pedagogical Methods and Principles at the Department of Building, Chemistry, Energy and Environment, 2005” [2]. Elements from this project have been used in a follow-up project, exploring a concept for teaching software tools. This project is described in a paper also presented on this conference [3].

Having worked on two projects addressing these issues, we have several suggestions for making the lecture more varied. We have developed a concept for student-teacher collaboration creating teaching material, and discuss how to benefit from students’ skills when learning the features of new technologies and software. We also discuss the problem of the lack of updated top quality text books for engineering purposes in Scandinavian countries, because of the limited market for such books describing local standards. As a solution, we propose an on-line, constantly updated ‘text-book’ using Power Point slides, created by students and teacher as joint teamwork.

MOTIVATION

Today, tuition is no longer based on the sole use of the blackboard, but increasingly on electronic learning environments. Fulfilling the demands from the modern student is a challenge for instructors. Lectures should be engaging, even entertaining. While there is an increasing demand for high quality teaching, it is a paradox that the time for preparation is steadily reduced. Creating high quality electronic teaching material, coordinating different sources of information, is time-consuming work. Therefore, teachers should find ways to make the preparation more efficient in order to avoid working a great deal over-time. A solution is to integrate the students in the process of creating teaching material, and presenting it in class.

After attending a course in pedagogy at OUC, we were inspired to explore some of the pedagogical principles suggested on the course. Topics of interest for further study were the lecture, student participation and development of electronic learning material.

1. The lecture

The lecture form is used excessively at the Faculty of Engineering, and classes are often large, the numbers of students ranging from around 30 to 500 on different courses. This poses several challenges for the instructors, because teaching a large class poses different problems than teaching small groups.

The lecture is ‘not a one-off event with a billed guest speaker, but a regular method of teaching throughout the semester. The majority of academics do not have the personal gifts, or the rhetorical skills to perform centre stage, inspiring students day after day’ [1]. Research has shown that lectures are as effective as other methods for teaching information, but
less effective than for instance unsupervised reading. They do not change students’ attitudes, and are ineffective for stimulating higher-order thinking like problem-solving and decision making. Students enjoy a good lecture, but on the whole prefer well conducted group work [4]. The question is therefore, why stick to the lecture form, if it is no better than other methods for passing on information?

Many teachers have developed a perspective on their field of expertise, something text-books normally have not. Also, text-books are soon out of date, partly through publication lag, whereas teachers and researchers are not [1]. Therefore, the role of the teacher is to transform knowledge. In order to do so, the knowledge should be passed on in a form that does not tire the students. Human learning is affected by unchanging low-level activity like listening to a lecture, because concentration is lowered by inactivity. Attention drops after 15 minutes. So, in order to retain attention, a change in activity should be introduced every 15 or 20 minutes, depending on the ‘students, the skill of the lecturer, the pace of the lecture, and the difficulty of the material’ [1].

The lectures can be varied by using a combination of electronic learning material, for instance Power Point presentations, the blackboard, task assignments and posing questions to the students, thus creating a dialogue between lecturer and students.

2. Student participation

Introducing a new text-book or subject means that a teacher must spend time creating appropriate teaching material. Modern teachers should always be updated on their subject, and be able to conduct a variety of courses. They must also be prepared to teach subjects they are not experts in. This means constantly acquiring new knowledge, and preparing appropriate teaching material. New teachers create most of the subject material from scratch. When preparing a new subject, it can therefore be a great help to hire a student to create the basic Power Point slides from the chapters in selected textbooks.

Many teachers will not integrate new technology into the study program until they master the software application and all aspects of the technology. In a pressured schedule, learning new software tools and technologies is often not given enough priority. It is our experience that talented students quickly learn new technology and software. When these students graduate, the knowledge disappears with them. We decided to benefit from the students’ knowledge by involving them in a process developing a method for learning new software. The work resulted in a program where teachers and students learn by teaching each other, and simultaneously create instruction material using Power Point presentations [3].

3. Learning environment

At OUC, the tool Classfronter, now known as Fronter, is used as a virtual learning environment. The tool is produced by a Norwegian firm, and is currently used in Scandinavia, Germany and Holland. According to the product sheet, Fronter lives up to its slogan ‘Knowledge through Collaboration’ by offering a state of the art web based and multilingual VLE (Virtual Learning Environment) where students and teachers alike can benefit from collaboration and learning. The Fronter VLE is developed in close cooperation with professional educationalist from leading institutions through national reference groups, and its pedagogic focus and ease of use makes the product tailor made for the educational sector’ [5]. The software has many facilities, is easy to use and provides many possibilities for collaboration between students and teachers. One of the features is the possibility to exchange documents, for instance lecture notes in PDF-format. This means flexibility for the student, since they can download the files any time. However, all teaching material must then be in electronic form, and this is a potential problem. Many teachers complain that they find it too time-consuming to produce Power Point slides. However, involving the students in the process of producing the basic material will make it possible.

OUTLINE OF THE PROJECTS

1. Project 1

The first project started in January 2005 and will continue until October 2006. The project receives funding for this period.

The project aims to:

- Involve students in the process of creating Power Point slides for all the lectures, with hand-outs. The aim is to improve the quality of the teaching material.
- Develop a colour code system for the creation of Power Point slides to aid the students in their work with the slides.
- Develop a standard Power Point template, in order to make the exchange and development of slides easy.
- Publish all material in Fronter, in order secure the information for students who do not participate in the lectures.

Project participants are teachers from the department of Energy and Environment, Building and Computer Science.

Students were hired to write the Power Point presentations using the specific template. When students write all the formulas and the basic text, time for teacher preparation is reduced with up to 75%, leaving the teacher more time for creating high quality teaching material. It can take up to three courses running (three years) to perfect the creation of advanced course material, but by using this method, the time spent can be reduced dramatically.
2. Project 2

Project 2 started in January 2006, and will continue until January 2007. It is described in detail in [3].

Teachers are pressured for time, and it is a serious challenge to become familiar with new tools and technology. Exploring a variety of software tools in order to decide which is the most suitable is time-consuming work. Letting students teach each other new software and creating a user manual in Power Point simultaneously can ease the pressure on the teacher. By incorporating the exploration of the software’s features into a tool-learning project, the gain is many-fold.

The aims of the project are to create a team of teachers and students working together on the tuition of other students and teachers, creating the instruction material, and exploring the benefits of this method of learning. This includes:

- Incorporating the students into the teaching process, thereby gaining from their skills
- Learning to use the software, spreading the knowledge amongst the students
- Deciding on the suitability of the tool for specific purposes

Project participants are teachers and students from the departments of Computer Science, and Energy and Environment. The assumption is that when experts from various fields participate, the information obtained is more varied and hence improves the project results [3].

Creating the Instruction Material

In order to create high-quality instruction material for hand-outs, we recommend the following approach:

- Use a standard Power Point template
- Mark the text with different colours (colour code system)
- Transform the code into text
- Review text
- Correct draft, and add supplements

Jørgen Christensen has developed a code system for marking the different parts of the selected text as headlines, bullet points, normal text and notes using different colours, see figure 1. Selected chapters in one or more text books are marked using the colour code, making it possible for the student to understand how the text should be transformed into Power Point slides. A simple notation is added in order to specify capital letters, font size and slide numbers.

Using a standard template ensures that although many people are involved in the process of creating the slides, these will be in a uniform format. Christensen’s experience is to use only a few codes and colours, because the students easily forget or mix up the codes if there are too many different symbols. The system should be kept as simple as possible.

In the example in figure 1, the codes give the following information to the students:

- Blue: Headline
- Pink: Normal text (bullet point)
- The number ‘10’: Slide number 10
- A box with the number 2: Template number 2. (A list of Power Point templates is included).

The text marked with pink means text with bullet point. A text at a lower level is underlined with a pen. A text line with no bullet point is marked with ‘NB’ (no bullet). Capital letters are marked with ‘CL’.

Figure 2 shows the finished result when the text in figure 1 has been transformed according to the code system.

FIGURE 1
Example of how the text is marked using different colours.

Varmestron – Overflater

- Ytre overflater – lining (3.5):
  \[ \Phi = \frac{A}{R_u} \cdot (t_{ou} - t_u) = \alpha_u \cdot A \cdot (t_{ou} - t_u) \ (W) \]

- Indre overflater – lining (3.6):
  \[ \Phi = \frac{A}{R_i} \cdot (t_i - t_{oi}) = \alpha_i \cdot A \cdot (t_i - t_{oi}) \ (W) \]

FIGURE 2
The text in figure 1 transformed into a Power Point slide.

When the draft for the slides is ready, the teacher reviews them, and gives the students correcting comments. The students will quickly become familiar with the template, and are able to make high quality slides from the draft. This process speeds up the time spent for preparation by a factor of 3 to 4. When the final draft of the Power Point slides is completed, the teacher can add supplements, and include material from other sources. Some readers may think that this...
is an extremely time-consuming process, but our experience is that it is a very efficient way of using Power Point presentation to create a compressed text book. The approach makes it possible to include updated information from scientific papers, conference articles and magazines.

When creating tutorials for the tool-learning workshop in Project 2, the use of Power Point has certain advantages. There is limited space per slide, and the information presented is therefore concentrated. The tutorial is created ‘on the fly’, while using and learning the software. Both teachers and students contribute with their acquired experience. The instruction material created in this manner is highly flexible, and can easily be changed and updated. Using a Power Point format ensures that the most important information is presented first, and details are postponed until a later stage. Practical examples and solutions to exercises are incorporated into the presentation [3].

1. The Power Point Format

Even with very clear written and spoken information, most of the students will not be able to correctly follow the template, and some students simply create their own format. One difficulty is that Power Point has many different formats and versions. This means that one can never be sure that the student has the same version of Power Point on their computer. For this reason, we always distribute the exact format in a file, and ask the students to make 3-4 Power Point slides and return them, so that the slides can be controlled to see if the format is correct. The instructor corrects the slides and returns them with comments. Some of the students pick up the template format very quickly, while others have difficulties understanding a clear message, and have to be corrected several times. It normally takes two rounds checking the format, sometimes even more. This may sound complicated and time-consuming, but in the long run it is our experience that once the students are familiar with the format, it is possible to create new teaching material very quickly.

2. Including female students and minority students

Women fall away from engineering studies and careers in engineering. This phenomenon is known as ‘The leaky pipeline’, a term used by the European Commission [6]. The main problem is not how to recruit female students, but to retain those that have entered the studies. According to a EU report, ‘attracting more young people into science poses challenges for education. The sex stereotyping […] needs to be tackled through the curriculum, through pedagogy and through the media. Various strategies to encourage women to enter and remain in science are recommended. These include role models, mentoring, networks, schemes for parents returning after career breaks, and encouragement to women to apply for fellowships and posts.’ [6].

There is a large under-representation of women in the engineering studies, and women often find themselves alone in an all-male environment. The teacher who is aware of this fact can help to create a learning environment that appeals to women, for instance by including them in the process of creating teaching material and giving presentations. This will heighten their self esteem, and provide valuable experience. It is important that the women are not regarded as secretaries, but as partners with influence. These issues are discussed in greater depth in a paper also presented at this conference [7].

Minority students have similar, but also specific needs. We have experience with teaching groups of foreign students, including them in a larger group, in order to avoid ethnic segregation. For instance, there are several Russian students at the University College of Narvik, Norway. Traditionally, they gathered in Russian groups, something which led to language problems in their further studies. However, on the introduction course for new students special exercises were selected in order to let all the students get to know each other. The result was that the project groups were composed of both Russian and Norwegian students. At the faculty of Engineering, OUC, approximately 40% of the students are minority students from all over the world. Including the task of writing Power Point presentations under teacher supervision will improve language skills, and lead to better integration of minority students.

3. The use of references

It is recommended to note the exact literature reference on all the slides, as it is not enough to give a few references on the first couple of slides. In the process on creating the material in Power Point, one is actually writing a form of flexible text book, where material is included from many different sources. After a while, it is not possible to know where the information comes from. Our experience is that a complete literature reference is necessary on every single slide, including ISBN number and page numbers, in order to respect the intellectual property rights of the original authors.

In the presentations, we have also included several exercises, along with their solutions. In this way the students receive all the information they need contained in one file. In addition, the instructor can create a presentation with only exercises, and no solutions. It may be argued that the solutions should not be included together with the theory and exercises, as it is giving the students too much for free. However, this is a practical consideration in order to limit the presentation to two files, where the exercises are extracted from the original, complete file. Another reason is that the students wish to have all the information collected, so that they can work on the exercises on their own.

4. A Discussion of Text books

For specific tasks in the area of engineering, for instance in energy and building design, Norwegian text books must be used in order to teach local standards. Norway is a small country with only 4.5 million people, and the market for technical books is limited. The quality of these books may have difficulties in matching the standard of American books produced for a worldwide market, and therefore, Norwegian teachers spend a lot of time making exercises and solutions themselves.

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The reason why foreign text books often are unsuitable for our needs is that many standards are different from Norwegian standards. The following example of calculating the so-called ‘U-values’ in buildings, illustrates the problem. A U-value is a measure for the transmission of heat through a wall. According to US standards, the U-value measures heat transmission through the entire wall in question, for instance a wall of 20 m². The U-value has the unit W/K. In Scandinavia, the U-value is a fixed value, independent of the size of the wall. All walls have a U-value equal to for example 0.2 W/m² K, whatever their size. In Scandinavia, the U-values are used in the Building Regulation Code in order to describe minimum requirements for the insulation quality of the wall.

5. Documentation

Electronic course material can be used as a documentation of the teacher’s work, and as quality control. Publishing the course material electronically makes it easy to conduct external quality control. The material can also be used by other instructors who later conduct the same course.

A teacher who has put a lot of effort into creating high-quality course material should not be forced to take on other courses after only a few semesters. On the other hand, having created extensive material should not be an excuse to monopolize the course for years on end.

6. Copyright considerations

When using material from several different sources, there are copyright regulations one must be aware of. In Norway, the organisation “KopiNor” enforces rules of how teachers in Norway can use copied material from textbooks. These rules give permission to copy up to 15% of the material from a book without paying a fee to the authors. Instead, the Norwegian Department of Education has made an agreement with the authors’ organisation to pay a yearly fee, and this payment is distributed to the authors. In this way, it is possible to copy from several books. As far as we can determine, how to refer to sources in Power Point slides has not been clearly defined.

EXPERIENCE AND RECOMMENDATIONS

1. Structuring and varying the lecture

The teacher should give a brief repetition from last lecture at the beginning of each lecture, and a 3-5 minutes consolidation at the end of the lecture. Alternatively, the students can do the summing up by giving a short review to each other. Hand-outs of the Power Point files are distributed to the students at the beginning of the lectures. This ensures that all the students have access to the notes at the beginning of class. If information is not clearly understood, the slide can be updated on the spot or right after the lecture. When all the course material has been created, the major part of it can be handed out at the beginning of the course.

Using PowerPoint presentations with hand-outs for the students gives the students more information in a shorter time. However, it is important to avoid the lecture ending up as a “Power Point slide show”, which will tire the students. Reading out loud form the slides must also be avoided, because it will seem pointless when the information is on the hand-out, and also published in Fronter. If a lecture does not offer something that is not contained in a text book or other sources, it can not be justified [1].

The presentation in the PowerPoint slides should be so excessive that the students only have to take a limited number of notes. Taking too many notes will create “black holes”, because while taking notes, students do not hear what is being said, and information will be lost [1]. This can be avoided if the lecturer gives the relevant information in the notes. For example, if the lecturer shows a picture or a diagram, at the same time giving extensive verbal information, it is a good idea to show this information on a slide before or after the illustration. We have several times experienced presentations where the lecturer has given a lot of valuable information about an illustration, but have been unable to put all the information down on paper, even if we are experts in the subject. How then can the students be expected to handle all this information? However, it is important that time is not spent reading from the slides, since the students can read the information themselves.

2. Student participation in lectures

There are several ways of stimulating student participation during the lecture, for instance by giving the students a specific text or article to prepare and present in class, and to create small exercises for the rest of the class to solve. If the students make PowerPoint presentations of their work, it is easy to integrate it with the teacher’s material for use in futures lectures.

Students can also act as learning partners, explaining theory to each other. Student-to-students lectures represent a different form of teaching than the traditional teacher-to-students lecture. Students take instructions from their peers seriously, and this is one of the reasons for the use of student assistants in the educational system. It may also give the teacher ideas on how to perform on the teacher-to-student level.

When students prepare part of the lectures, they will acquire knowledge of how to present material for educational purpose. Experience with students teaching each other new software tools is presented in the paper “A Concept for Flexible Teaching of Software Tools in Engineering Education” [3].

3. Task Assignment

Tasks can be solved individually, in pairs, or in small groups, depending on the lecture room facilities. Such tasks can be

- Problem identification
- Problem solving
- Small tests with test correction: student correct their own or each other’s tests
- Brainstorming
• Discussions

One should be aware that when solving problems, some students finish quickly, while others spend more time. If students get bored, they will feel that the teaching process is slowed down by the breaks. It is therefore recommended to give two or more exercises, so that there will be enough work for everybody. The instructor can also use the blackboard to solve the exercise at the same time as the students, involving them in a dialogue with questions and answers. If the class is not too big, discussions can be conducted. However, there is a danger of falling into quasi discussions, sessions in which students talk but fail to reflect on the process and outcomes of the discussion. Two common forms of quasi discussion are ‘quiz shows’ where the teacher has the right answers, and ‘bull sessions’, characterized by empty generalizations, and aimless talking [8]. In order to avoid this pitfall, one can break the class into small groups or assign tasks to pairs of students, or discuss the issue in groups and choose one student to speak.

4. Mini-writing

Mini-writing is a technique where the students read a text, and then a short writing and talking sequence write a few lines about a question from their reading in their own words. The idea is to define a concept, or summarize an issue. The students then share their writing in small groups for a few minutes, and present their understanding of the text to the class. An example of the use of this technique is given in [9]. It is a very informal approach to writing, in order to structure thought, and structure the material.

CONCLUSIONS

We have received student feedback for two different courses, Fluid Dynamics (2006) and Software Engineering (2005). Teachers have different opinions on whether to publish the material openly on the Internet, in Fronter, a closed system where the students must log on, or distribute them to the students as hand-outs. One group of teachers feel that in order to publish their notes electronically, they must be perfect and they spend too much time perfecting them, and therefore do not wish to publish them electronically. Other teachers willingly publish their notes on Fronter, while a third group have no objections to publishing them on the Internet, open to all, arguing that it is a way to exchange information with other colleges and Universities.

We have tried two different approaches. In Fluid Dynamics at the department of Energy and Environment, the students were given handouts before lectures. The slides have not been published in Fronter, but the intention is doing so next semester. In Software Engineering at the Computer science department, all slides were published as PDF files on the course web-page, but no hand-outs were distributed.

Feed-back from the students show that they are very satisfied both with the Power Point handouts, and the electronic slides. The students who receive hand-outs regard them as supplementary material, in addition to text books and project work. The hand-outs give an overview of the course topics, but the students must attend the lectures in order to benefit from the distributed material. 70-80% of the students take part in the lectures.

The computer science students have access to all the slides electronically, and either read them on-line, or print them out. However, many of these students feel that they do not have to attend lectures, as the slides contain both an overview of the general topics, and several exercises. Often, only 40-50% of the students attend lectures. We have not been able to determine the significance of these results. More research is needed in order to analyze effect of the different publishing forms has on student attendance.

In the course of three months, the project team of Project 2 has succeeded in teaching a number of students in the departments of Energy and Environment and Computer science to use Mathcad for engineering tasks. Interviews with the students show that they appreciate being taught by their peers. They have contributed to the user manual by giving feed-back of their experiences with the tool. These, together with written examples of calculations are being included in the Power Point user manual.

REFERENCES