

Pre-lecture Assignments - a Method for Improving Learning in Engineering Education

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Abstract – New knowledge is constructed on the basis of prior knowledge. Present engineering classes are often heterogeneous in their background knowledge, which generates extra challenges for both students and lecturers. In our studies we have used pre-lecture assignments to help deal with students' heterogeneous backgrounds. The pre-lecture assignments have been designed so that students in doing them recall former issues or get acquainted with new topics, or both. Students have done and turned in their pre-lecture assignments in various ways. In most cases, an essential feature was that the lecturers were able to view the answers before the lecture. Pre-lecture assignments have motivated students to spend more time studying the subjects concerned and to come to class better prepared. New concepts become more comprehensible and deeper understanding easier to achieve when students master relevant prior knowledge. When students are acquainted with the new upcoming topics and master the necessary prior knowledge valuable lecture time can focus on the more difficult issues and concepts. Students have seen the advantages of doing their pre-lecture assignments and thus most students devote the necessary time to doing them. Students' active working in class and learning results have improved.

Index Terms – active learning, pedagogical content knowledge, pre-lecture assignment, prior knowledge.

INTRODUCTION

Most engineering students in Finland start their studies without any preceding work practice relating to their forthcoming studies and future occupations. In recruiting students, the faculties of engineering compete with faculties of medicine, law and business amongst others, which are all very popular choices. It is therefore difficult to recruit enough students who have a sufficient mastering of mathematical and physical sciences, which are a basis for most engineering subjects. This leads to student groups that are somewhat heterogeneous in their background knowledge. This seems to be the situation also in many other European countries.

According to the constructivist view of learning new knowledge is constructed and reconstructed in the mind of the learner. Learning and internalising knowledge demands an active engagement and mental effort of learners whereby they build their own knowledge. New knowledge is built on the basis of the learner's prior knowledge and new

knowledge must be related to the learner's earlier knowledge. Learners build connections between what they already know and have experienced, and new information they perceive and new ideas and experiences. [1]-[3]

The information processing model suggests a model of our memory system and of how humans process information (Figure 1) [4]. The sense receptors accept almost limitlessly information. The information is briefly held in the sensory memory. Relevant information moves on through the perception filter to the short-term memory and irrelevant information is forgotten. Prior knowledge, interests and motivation influence what passes through the perception filter. The processing and organization of new information with prior knowledge that is retrieved from the long-term memory takes place in the short-term memory. The newly formed knowledge structures are stored into the long-term memory either as separate knowledge or integrated into larger knowledge entities. The capacity of the short-term memory is limited considering both time and amount of information. The capacity is shared between processing and holding information. In order to process new information as efficiently as possible, the relevant prior knowledge should be easily available for the short-term memory to process and thus retrieving knowledge from the long-term memory should not take too much effort when new information has to be processed.

Taking into consideration the impact prior knowledge has on learning, lecturers should have good knowledge of their students' existing conceptions and possible misconceptions, and a means to acquire insight into student knowledge in order to promote good learning results. Many studies have revealed that the time that students spend studying is less than presumed in curricula [7]-[8]. One reason for this might be that students find some engineering subjects too difficult and give up or turn to a surface-approach. The time resources for lecturing and teaching theory are also usually limited. These are reasons why some means to achieve more efficient time use and a deep approach to learning should be explored.

This paper describes a means, using pre-lecture assignments, to get students more involved in their studies i.e. to spend more time studying and preparing themselves for lectures. Results on the impact of pre-lecture assignments on students' learning and lecturers' improvements of professional teaching skills are discussed. This research is a case study and can be classified as action research with evaluative features.

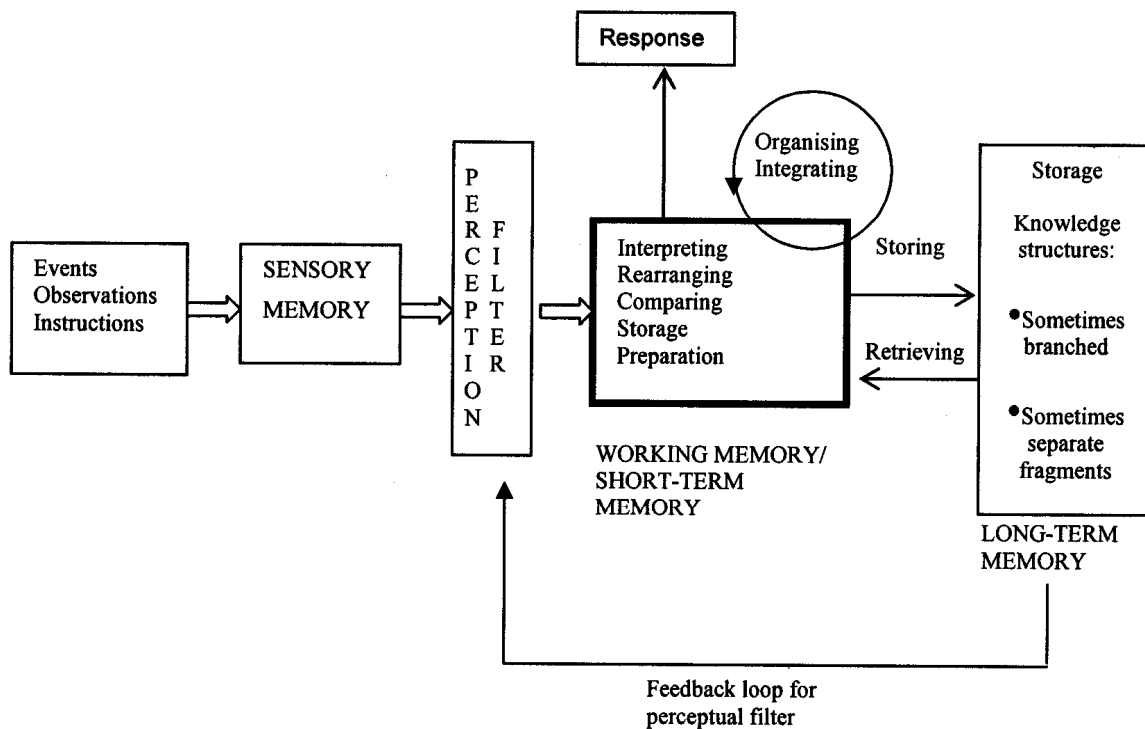


FIGURE 1
 INFORMATION PROCESSING MODEL MODIFIED ON THE BASIS OF MAYER [4], JOHNSTONE [5] AND KOLARI AND SAVANDER-RANNE [6].

PRE-LECTURE ASSIGNMENTS

Including pre-lecture assignments in the working mode helps to use lecturing time more efficiently. The pre-lecture assignments can be compiled so that they focus on some issues of the upcoming next lectures and/or on issues which are requisites to some new issues and which have been dealt with earlier. Attending lectures and processing new information will become easier for the students when they have familiarized themselves with the new issues and recollected relevant prior issues. As we can see from the information processing model, the students need to have some of their prior knowledge in an active form in their memory so that they can focus on processing information, i.e. integrate the new knowledge with their prior knowledge and organise everything in order to form their own personal knowledge structures in their long-term memory.

When planning and assigning pre-lecture assignments lecturers have to reflect on their courses. They have to think about course content from the students' points of view, consider if the students' prior knowledge is relevant and sufficient, recall experiences from earlier implementations and try to compare the new student group with the earlier ones.

They have to consider for example:

What concepts do the students have to know in order to cope with the new ones that will be introduced?

Do the students know all necessary formula and propositions? Do they understand their meaning? Are they able to use them?

Do they have a sufficient mastering of the mathematics they need?

How well are the students able to transfer their knowledge into new situations and solving problems?

When the students have done their pre-lecture assignments or at least made a serious effort to do them, lecturers can focus on the more important and more difficult topics of their lectures instead of spending time on issues that the students should be able to cope with on their own. They can use a broader scope of interactive teaching methods because pre-lecture assignments have brought more homogeneity to the class. Students are better able to contribute to different forms of group work, co-operative learning sessions, problem solving sessions, etc. This has a positive effect on student motivation and self-efficacy. The students can feel that they have an important role in the teams and are able to contribute to achieving good results for their group or team.

Research has been done in Finland on the use of pre-lecture assignments at various courses and at various institutes such as Tampere University of Technology [9], Tampere Polytechnic University of Applied Sciences [10] and Helsinki Polytechnic University of Applied Sciences [11], where engineers are educated. The target groups have been MSc or BSc students and the group sizes have varied from small to large, less than 40 students and more than 100 students. The pre-lecture assignments have been distributed in many ways. Sometimes as paper copies at the lecture but mostly using some form of electronic communication such as WEBCT or Moodle. The students have handed in their assignments in some cases as paper copies, but mostly using electronic communication. They have worked individually or in pairs or small groups.

It is important that the lecturers are able to read the students' answers to the pre-lecture assignments beforehand or at least summing ups made by for example their teaching assistants. For this reason the pre-lecture assignment should be handed in at least one day before the lecture for which they were compiled. This way the lecturers have been able to learn about their students' prior knowledge of relevant issues, their possible misconceptions, and what has seemed especially difficult. The lecturers have been able to give the students feedback on their answers at the beginning of the lecture and try to correct the students' possible misconceptions. This has helped the students follow the lecture and participate more actively in different forms of interaction. The pre-lecture assignments have been a part of the assessment and have in one form or another influenced the grade. Usually a student gets extra points for doing the pre-lecture assignments. In order to get points, an answer does not necessarily have to be correct; it is enough if a student hands in an answer and shows an earnest effort and has clearly spent some time trying to find a correct answer or solution.

RESULTS AND DISCUSSION

The results are based on questionnaires, which were distributed during the courses, on feedback questionnaires, interviews of students and lecturers, on perceptions of the lecturers, and on observations of the researchers attending the lectures. In view of learning goals, the results have been encouraging and awarding to all parties. The students have been better able to concentrate during lectures, they have been better able to understand what is taught and better able to process new information and to participate in interaction during lectures. This has led to better learning results. The students have attended their exams more diligently and the passing rates have increased. The number of students that pass their exams with only modest results has reduced. The students have also spent more time studying. Earlier studies on student time use have in many cases shown that students spend less time studying than expected and allocated in curricula [8]. Thus the increase of one to two hours per week that students have spent on their pre-lecture assignments is well appreciated and has positively influenced their learning.

The students have given positive feedback on pre-lecture assignments:

"Pre-lecture assignments helped me prepare myself for the lectures, usually I don't."

"It was easier to follow the lectures and understand when I had activated my brains towards the new issues."

"I recollected issues from my physics course and realised that it wasn't necessarily the whole truth. Pre-lecture assignments motivated and made me read from other sources".

"I thought about things more thoroughly. It was nicer to come to class when you got feedback on the pre-lecture assignments".

"Pre-lecture assignments made me think about things from different aspects. I could see that things are not always simple and straightforward. They were good, they made me think"

Active participation during class is not self evident. It is most common, that students just want to maintain their old role of having information transmitted from lecturer to students. The reasons for this are often old habits and maybe fears of failure. Pre-lecture assignments, however, helped students prepare themselves and thus diminished their fears.

Lecturers, who have used pre-lecture assignments, have said that their knowledge, for example about their students' ways of thinking and ways of tackling problems, has improved. This has led to an increase of their pedagogical content knowledge. Pedagogical content knowledge (PCK) can be described as subject matter knowledge for teaching [12]-[14]. It includes knowing how to present and formulate subject matter in a way that is comprehensible. Pedagogical content knowledge also includes knowledge of what makes learning of some specific topic easy or difficult. Pedagogical content knowledge can be achieved by mastering subject matter and pedagogical knowledge, experiencing and reflecting [14].

Lecturers who have been lecturing for decades say that using pre-lecture assignments has taught them a lot and that they have found a new and more interesting way of lecturing. They have been better able to answer the cognitive challenges of teaching difficult issues to engineering students. They have, however, also noticed that making good and unambiguous pre-lecture assignments is not always easy. It demands constant critical reflection on experiences and course content, and interaction with students, colleagues and teaching assistants.

Feedback is one of the most important elements in enhancing learning. Pre-lecture assignments offer lecturers a possibility to give students guiding feedback regularly. Students have often mentioned in interviews and feedback questionnaires that they have appreciated the feedback that the lecturers give them on their pre-lecture assignments. "It is nice and very motivating to see that someone has truly puts effort in teaching us." Students have also expressed that doing group work and solving small relevant problems or doing hands on experiments have led to more successful learning. Preparing for the lectures has made it easier to work in class and get results. "You don't just have to sit around and wait for the lecturer to give the solutions." It has

become a common interest to do the pre-lecture assignments and prepare for class even if the subject matter wouldn't be of utmost interest. "I have to do the assignments, everybody else does". Thus a better commitment has been achieved and one can definitely see joint responsibility.

CONCLUSIONS

Using pre-lecture assignments has led students to participate more actively in their learning process. They have spent more time studying than earlier. Students learning results have improved and passing rates have increased. Pre-lecture assignments have created a learning environment where the lecturers have a possibility to give guiding feedback regularly. This has motivated and committed the students. Taking pre-lecture assignments in use needs time and effort but it has turned out to be rewarding also for the lecturers, their pedagogical content knowledge has improved. When planning how to deliver and how to hand in pre-lecture assignments, it is recommendable to co-operate with your institute's IT-service unit.

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