The Continuous Challenge in teaching Engineering to Students from a Society with no Tradition for Higher Education

The engineering programme in Arctic Technology from the Technical University of Denmark enrolls students from Greenland and Denmark. Since the Greenlandic students underperformed and had a high drop-out rate, several initiatives have been initiated to help the weak Greenlandic students. The results are analysed, and it is clear that even though the initiatives have proved popular, they have not fundamentally solved the problems in giving a higher education to young people from a society with a weak tradition for education.

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The intercultural challenges of engineering education in a Greenlandic context

Greenland is a modern society with Self Governance, but only half a century ago it was primarily a fishing and hunting society governed as a colony by a Danish elite. The rapid changes have left Greenland with many social problems, and compared to Western Europe relatively few finish education beyond public school. Since 2001 the Technical University of Denmark has offered a study program in Arctic Engineering primarily targeted at Greenlandic youth, but also students from, for example, Denmark, where the first three semesters are finished in Greenland. There are two main objectives for this program: to educate professionals with a deep understanding of the Arctic, and to give the Greenlandic youth a better chance of getting a higher education.

To align the teaching philosophy with the Greenlandic students’ cultural background, the curriculum structure has large interdisciplinary courses based on authentic local cases and intercultural group work.

This paper will focus on the challenges caused by many of the Greenlandic students’ weak academic preparation, and the fact that the cultural background embedded in the Greenlandic language can make it very difficult to comprehend topics at an abstract level. Additionally, the group work and the class teaching are challenging due to the culturally -based reticence and conflict -averse nature of many of the Greenlandic students, which gives the Danish students a dominant position. This often creates a negative spiral, where many Greenlandic students tend to withdraw from discussions, which are an important part of the education. The paper will discuss our experiences with handling these challenges.

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Towards an Analysis of Study Habits of University Students

This paper looks at the study workload for a sample of undergraduate students during 30 min intervals over 7x24 hours. Students at the Danmarks Tekniske Universitet in Denmark and the Universidad de los Andes in Bogotá, Colombia, took
part in the experiment, which focused on physics and mathematics students. Detailed data was obtained for the total study workload, the study workload during the day and during the week, the different study activities, and the differences in workload between different students. Significant differences are found between the study practices of the students at the two institutions. Further work is required to make adjustments to the teaching and learning programmes.

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**Culture In Engineering Education: CDIO framing intercultural competences**
As engineers today often work in intercultural projects and contexts, intercultural competences must be part of the learning objectives in engineering educations. Cultural aspects of engineering education should not just be treated as a question of appropriate communication and teaching: cultural aspects are basically part of engineering disciplines, work challenges as well as the contextual elements in engineering curriculum [1,2]. This is reflected in the aims of the CDIO programme [3,4]; however, the programme, as well as the teaching practises, undoubtedly needs to further develop approaches to cultural aspects in engineering education. Hence the key-question of this paper is how CDIO support the development of intercultural competences in engineering education. The paper explores the implementation of CDIO in an intercultural arctic engineering programme in Greenland that since 2001 has been enrolling students with special focus on developing intercultural competences. The discussion draws on the socio-technical approaches to technology and professional engineering practises [5,6]. We conclude that intercultural teaching is not just a matter of teaching in spite of cultural differences; it involves the ability to communicate across differences and foster mutual learning processes and approaches to problem solving. We also point to methods and lessons learned to address this challenge in practice. The discussions and findings of the paper have relevance in several ways. Firstly, it addresses the continuously development of CDIO, including the current discussion of a new principles [7]. Secondly it has practical relevance to the engineering education, which to a growing degree has to cope with the potentials and challenges of internationalisation of educations and thus intercultural classrooms. Thirdly it has a more general relevance for educational development as engineers most often are working in projects within different cultural settings and contexts and in culturally diverse groups.

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Interdisciplinary case-based teaching of engineering geosciences and geotechnics

The complete restructuring of the 4-year Professional Bachelor programme in Arctic Technology at the Technical University of Denmark in 2007 has provided the perfect framework for implementing CDIO-based courses with focus on a holistic and interdisciplinary approach. In this paper we present our experiences over four years teaching one such course, 11821 Site Investigations. The goal is to teach the students to conduct site investigations in connection with construction work in arctic areas. It covers technical skills and competences from several different branches of engineering in an interdisciplinary course. Course elements comprise the understanding of relevant geological processes and deposits, tools to examine and map these deposits, as well as the use of Global Navigation Satellite Systems (GNSS) and Geographical Information Systems (GIS) to collect and organize spatial information. Environmental aspects and cultural heritage screenings are also covered as well as group work and report writing. The course is constructed around a real world case, e.g. the construction of a specific road segment, and the students have to produce a realistic site investigation report based on field and laboratory investigations as well as theoretical considerations. The interdisciplinary structure of the course combined with the real-world case and just-in-time teaching applied has resulted in more motivated and hard working students, and as teachers we receive better and more interesting reports to read. However, the inter-disciplinary and practically oriented nature of the course poses special demands on teachers and instructors. Among these are more complex coordination among course elements, and difficult adaption of the curriculum. Based on written and oral feedback and our own teaching experience, we conclude that the new course form is an efficient and challenging way to teach engineering with good learning outcome over a broad spectrum of the CDIO syllabus.

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Active teaching methods, studying responses and learning

Students' study strategies when exposed to activating teaching methods are measured, analysed and compared to study strategies in more traditional lecture-based teaching. The resulting learning outcome is discussed.

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Active teaching methods, studying responses and learning

Students' study strategies when exposed to activating teaching methods are measured, analysed and compared to study strategies in more traditional lecture-based teaching.

De la actividad al aprendizaje activo: From Activity to Active Learning

De las competencias a los objetivos educacionales: From Competences to Learning Objectives
Interdisciplinary just-in-time teaching: Active learning in a multicultural setting

An active learning methodology in engineering education has been developed based on general pedagogical principles adapted to a mixed student group including students from a population with little tradition for higher education. So far it has been successful with engaged students and teachers and good learning outcome.

Guest editorial on Trends in Pre-College (K-12) Engineering Education: Part I

Guest editorial on Trends in Pre-College (K-12) Engineering Education: Part II
At the crossroad between behaviourism and cognitive constructivism

Many educationists recommend that learning objectives should be given in a behaviouristic way with directly observable actions. At the same time cognitive constructivism seems to be the preferred theory within the engineering educational community. There is no conflict in using a behavioural approach to assess final competences in a constructivist setting, but during an education we should evaluate the progress of the student’s learning. One way could be to look at the student’s errors.

Study strategies and approaches to learning

In this study students’ study strategies have been compared to their approaches to learning. The time students spend on different study activities has been investigated at the Technical University of Denmark, and as a pilot project a few students also filled in a reduced version of Bigg’s Study Process Questionnaire to identify their approach to learning. It was hypothesised that the students’ learning approach would depend more on the quality of the study work than on the quantity; that an active and reflective study strategy was required to obtain deep conceptual understanding. The result showed a weak correlation between the student’s main learning approach as defined by the ratio of the deep approach score to the surface approach score and the student’s study intensity as identified by the ratio of non-scheduled independent activities to scheduled teacher-controlled activities. There was however a much stronger linear correlation (significant at the 0.01 level) between the deep-surface ratio and the total study load. The same result was observed when measuring other students’ study strategy and learning approach for a single course. The empirical basis is still too limited to draw conclusive conclusions, but it raises some intriguing questions. Is time more important than the kind of learning activities for obtaining conceptual understanding – is all that matters from a teaching point of view to ensure that the students spend long hours studying?
Creating a Learning Environment for Engineering Education

Until recently discussions about improvement of educational quality have focused on the teacher – it was assumed that by training the teacher you could increase the students' learning outcome. Realising that other changes than better teaching were necessary to give the students more useful competencies, the idea of faculty development was introduced. But even this is not enough. The saying has for some time been 'from teaching to learning', but very little attention has actually been on the students' learning through active studying; how should the student study in a learning-effective way? And the introduction of IT has highlighted the importance of the learning environment, but the focus has narrowly been on the physical environment. However, the mental framework is also very important. To assure educational quality it is necessary to take all these elements into account and consider the total learning environment as an integrated whole.

Seven-step problem-based learning in an interaction design course

The objective in this paper is the implementation of the highly structured seven-step PBL procedure as part of the learning process in a human-computer interaction design course at the Technical University of Denmark, taking into account the common learning processes in PBL and the interaction design process. These two processes share many characteristics, and the most prominent are: How to explore, analyze and define the problem space, the importance of team-work and development and finally creativity to design and find a solution. We have experimented with additional short mandatory individual reports after each case in the PBL-process in order to explore the students' inter- and intra-personal team skills development in the learning process. Different qualitative and quantitative evaluation methods have been used to obtain a thorough evaluation of PBL used as a learning method among others in a single course. The evaluation results showed that the students definitely took a deep approach to learning, and indicated clearly that the students had obtained competences not only within the traditional HCI curriculum but also in terms of team-work skills.
The double-loop feedback for active learning with understanding
Learning is an active process, and in engineering education authentic projects is often used to activate the students and promote learning. However, it is not all activity that leads to deep learning; and in a rapid changing society deep understanding is necessary for life-long learning. Empirical findings at DTU question the direct link between high activity and a deep approach to learning. Active learning is important to obtain engineering competencies, but active learning requires more than activity. Feedback and reflection is crucial to the learning process, since new knowledge is built on the student’s existing understanding. A model for an active learning process with a double-loop feedback is suggested - the first loop gives the student experience through experimentation, the second conceptual understanding through reflection. Students often miss the second loop, so it is important that teaching explicitly support the generalisation of contextual knowledge to transferable generic knowledge.

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Study Strategies for Engineering Students at DTU
The study strategies of first year Master students are investigated at DTU fall 1999 - spring 2002. The results show that the students study less than their teachers expect. And they spend most time on activities not leading to deep understanding and engineering competencies. The students spend almost half of their study time on theoretical calculations and only little on authentic problems. They attend many lectures but read very little. This may be a reasonable response to the teaching and examination they encounter; but not with respect to learning. Changing the teaching structure at DTU has activated the students, but not significantly increased their independent studying.

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Developing critical reflection as a part of a teaching training and teaching practice
Academics in universities can no longer teach in the ways that have been appropriate in the past. The paradigm has shifted from the dissemination of knowledge to a focus on the students and how to facilitate the best learning outcomes for them. This paper proposes that critical reflection is at the heart of being an effective teacher. It invites teachers to evaluate their own philosophies about teaching and to be critically reflective on their own practice. It is suggested that teachers need to learn how to be reflective practitioners through both self-evaluation and the use of collaborative strategies. It is no longer appropriate to focus solely on the ‘what’; but also on the ‘how’ and ‘why’.

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Two different assessments methods are evaluated. Assessment of theoretical competencies through project work and assessment of theoretical competencies through group assignment.