ARCTIC ENGINEERING STUDENTS CHALLENGE

- Recommendations from the workshop

Sisimiut, June 2010

Pau Boffil, Michael Christie, Mauricio Duque, Erik de Graaff, Anne Hernandez, Patricio Poblete & Valquiria Villas-Boas
Introduction

Since 2001 the Technical University of Denmark (DTU) offers a 4-year engineering programme ‘Arctic Technology’, aiming to train engineers for work in Arctic conditions. The first one and a half years of the curriculum takes place at Sanaartornermik Illinniarfik (the Building & Construction School in Sisimiut). Sisimiut is the second largest city in Greenland, situated 50 km north of the polar circle. During the next two year the students go to Denmark where they follow standard courses at DTU.

<table>
<thead>
<tr>
<th>year</th>
<th>sem</th>
<th>General study structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Arctic courses at Arctic Technology Centre in Sisimiut</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Mandatory engineering courses at DTU</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>Engineering practice in the Arctic</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>Selectable courses in Denmark or special semester at NTNU</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Individual course Final arctic project</td>
</tr>
</tbody>
</table>

Since the start of the programme a relatively high dropout rate among Greenlandic students and delays before graduation have been observed. In order to deal with these issues a new programme structure has been implemented in 2007 emphasizing integration of practical work and theoretical learning. (Christensen, 2008).

Even though the first experiences with this new curriculum structure were positive, the problems appear not to have disappeared completely. Explanations for the low retention rate are to be found in two areas:

a. Low engagement of engineering students (resulting in the challenge of adjusting to socio-cultural change)

b. Insufficient competences at the entrance (in particular mathematics and sciences)

In the summer of 2010 a workshop with international experts was convened in Sisimiut, with the assignment to analyze the problem and to come up with suggestions to improve the situation1:

1. How to improve performance after transfer to Denmark

2. How to increase engagement and development of identity as an engineer

---

1 Acknowledgement: the workshop was supported by a grant from GrønlandsBankens Erhvervsfond
Taking into consideration the following condition:
- without changing the basic structure of the educational programme in Denmark or before entering the course

The workshop took place from Monday June 14 till Friday June 18. The programme aimed to give a short introduction on the local situation with presentations by Head of study programme Associate Professor Hans Peter Christensen from DTU and Associated Professor Wolfgang Kahlig from Ilisimatusarfik (the University of Greenland) and a visit to a school in the settlement Itelleq. Individual contributions to the programme were made by Erik de Graaff with a workshop on design of the learning environment, Mauricio Duque with a contribution on a project called “little scientists”, a presentation on the “Engineer of the Future” by Valquiria Villas-Boas and a short resume of the situation of the aboriginals in Australia by Michael Christie. Working together in two small groups the participants collaborated in the problem analysis, each bringing his/her own expertise in higher engineering education.

As participants of the workshop the members of the Active Learning In Engineering Education (ALE) steering committee were invited. Unfortunately the president Mark Somerville was at the last moment unable to attend. See below for a short bio-sketch of the participants.

**Pau BOFFIL**
- is associate professor at the Computer Architecture Department at the Universitat Politècnica de Catalunya, where he teaches computer programming to telecomunication engineering students. He believes in active and student centered education, and his main interest is helping students to learn autonomously. He has been a member of the ALE steering committee since 2008.

**Michael CHRISTI**
- is professor of Higher Education at the Education Department, Stockholm University. His research interests include equity and diversity in Higher Education, the use of ICT in improving learning in Higher Education and assuring quality learning in Higher Education. He is part of the Nordic Network on Engineering Education Research

**Mauricio DUQUE**
- is associated Professor of the engineering school at Los Andes University, Bogotá Colombia. His researches are focus on engineering education and science and technology education for all. In both aspects he is interested in the didactic of those disciplines, in academic and professional development schemas and in students' evaluations of learnings.
Erik de GRAAFF
- is associate professor at the faculty of Technology Policy and Management of Delft University of Technology and Professor at the Department of Development and planning at Aalborg University in Denmark. He has contributed to higher engineering education with over one hundred publications and through participation in professional organisations like SEFI - the European Society of Engineering Education, IGIP - The International Society for Engineering Pedagogy and ALE - Active Learning in Engineering Education. Currently he is Editor-in-Chief the SEFI journal: the European Journal of Engineering Education.

Anne HERNANDEZ
- is a senior lecturer in INSA Toulouse. She has been involved in applied research in active learning in English for engineers and, as a member of the pedagogical support group, has contributed to the introduction of active learning and PBL across the curriculum in the school.

Patricio POBLETE
- is a Mathematical Engineer (U. of Chile), has a Master's degree and a Ph.D. in Computer Science (U. of Waterloo, Canada), and is Full Professor of Computer Science at the University of Chile. His main research interests are Data Structures and Analysis of Algorithms. Currently he is the Director of the School of Engineering and Science of the University of Chile, where he has led an effort to change to a student-centered curriculum focused on learning outcomes and active learning. He is also the Director of NIC Chile, the Internet domain name registry for the Republic of Chile.

Valquiria VILLAS-BOAS
- is a full professor in the Centro de Ciências Exatas e Tecnologia (CCET) at the Universidade de Caxias do Sul (UCS) where she teaches basic physics for engineering students. She is the coordinator of the project ‘UCS-PROMOVE: The engineer of the future’. She is an advisor at CCET for faculty training, education quality and active and autonomous learning in engineering and science education.

References

Christensen, Hans Peter (2008) INTERDISCIPLINARY JUST-IN-TIME TEACHING Active Learning in a multicultural setting, Arctic Technology Centre, Technical University of Denmark. Presented at the 2008 ALE workshop in Bogota, Colombia.
Recommendations

Proposed measures group A

I. Testing of competences
   - Introduce pre-test in all subjects.
   - A diagnostic test could be used to identify weak areas in the candidate’s knowledge followed by remedial teaching for individual students to focus on these areas.
   - A standardized test provides insight in the candidate’s position in a reference group. Students are made aware of their position as compared to their Danish counterparts.
   - Introduce continuous formative testing
   - Support use of (online) self-tests (involve teachers from Denmark in the development).
   - Create a bank of quizzes

II. Tutoring
   - Teaching others is the most effective way to gain knowledge. Applying this principle you can make small student groups for self-study facilitated by more advanced student. Facilitating the learning for younger students should be a special course and all students should take part in this. The study groups should continue when they go to Denmark.
   - Set up a support center which administers different types of tutoring, like homework support, peer tutoring and expert consultancy. The students involved in the support center should be rewarded by either money or study points.
   - Set up support for secondary school students (could be in the same support center). Involve engineering students in tutoring secondary school students.
   - Work with the fact that some students are better than average and provide a project course for them where they get points or money for individual and small group tutoring where the day’s work can be explained or revised, where homework can be supervised.

III. Pedagogical strategies
   - Introduce special workshops to help students developing communication skills (oral and written presentations, leadership, etc).
   - Continue and expand on connection with local Greenlandic speaking agencies for project work. Verbal reports in Greenlandic with help writing an academic summary in Danish.
- Support setting up extra curricular projects initiated, organized and owned by the students.
- Encourage reading books and other socio-cultural activities.

IV. Curriculum structure
- We believe that the Danish curriculum with several theoretical disconnected courses in parallel is less effective than an integrated curriculum based on active learning.
- Courses like statics need to be spread over a longer period in order for students to have time to mature the concepts.
- Students need to be prepared to deal with the Danish curriculum. Therefore it could be helpful to have some courses overlap.
- Work with online teaching in addition to flying in experts for a few weeks at the time. In Greenland the students are supervised by a “Tutor”. If necessary the teaching staff who facilitates the learning may have to be extended. The tutor should be present at all learning sessions.
- Continue and expand the Greenland curriculum focused on competencies and working with projects. The projects could emphasize the different roles of engineers in society, and demonstrate to students the usefulness of the competences in solving real life practical problems. Projects in the third semester could aim for solving real problems in local communities and companies could pay for solutions to those real problems. Students acting the role of engineers in the field could strengthen their engineering identity, and it could also provide role models for younger members of the community.

V. Engagement
- Encourage the students to organise a student society that will provide a student representative for school meetings and decisions.
- Invite Greenlandic alumni to share their experiences with newcomers.
- Encourage students to participate in competitions representing their school.
- Strengthen the identity of the Arctic Engineer.

Proposals from group B

Academic improvement
- Diagnostic performance assessment
- Individualized diagnostic support and contract: A remedial programme should be established for each student including a study contract between each student and a person in charge.
• “Remedial” activities:
  o virtual courses (math, science)
  o students help students - peer tutoring
  o community learning
  o teachers coming from DTU could do some remedial courses in their field in addition to the course for which they are 'officially' in Greenland
  o homework mentoring (students and/or teachers)
  o math and science center (guided by students and teachers)
• Language / communication course included in the curriculum
• Supervised (with academic recognition) activities in parallel (seminars, sport, arts, social support) (generic competencies i.e. planning, initiative,...)
• Improve engagement :-)
• Allow for individual necessities, rhythms and styles of learning (within PBL)
• Allow for self decision-making somewhere along the project.
• Set peer activities as deadlines to foster study habits
• It is important that the practical case based approach is implemented in all courses.

Engagement
• Pre engineering high school workshop (summer camp with pre engineering activities)
• Initial 1-2 week engineering workshop
• Individualize professional belief and expectation building to help make reasoned, appropriate choices and build a coherent professional project - Individualized professional guidance by coaches from industry to build a portfolio
• Value community commitment (Arctic engineering-high school education - tutoring others - be involved in social community activities with reflection)
• Preparation to live in Denmark (i.e. Fulbright Workshops)
• Create conditions for:
  o Participation = making their own decisions + taking responsibility for them
  o Relevant, interesting, necessary, real, amusing... activities
  o Make them feel they can do it -- Build self-esteem
• Let them build their own:
  o Vision of their country / lifestyle
  o Concept of engineering
  o Ways of earning their living, etc.
• Help them find their vocation even if that means leaving the program.
• Take actions in order to get Danish and Greenlandic cultures closer together. Use Greenlandic language, prepare materials in Greenlandic (maybe the students themselves)
• Run discussions on social issues of Greenlandic engineering (Example case study: modern vs traditional house building)
• Run a seminar like this one with your students. Goals: improve engagement, and learning efficiency. Let there be room for them to make their own decisions and commit to them.
Appendices

Figure 1. Overview of the educational system
Figure 2. Overview of interventions