

CULTURE IN ENGINEERING EDUCATION CDIO FRAMING INTERCULTURAL COMPETENCES

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ABSTRACT

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.

KEYWORDS

Intercultural competences, engineering context, authenticity, community networking, programme development.

INTRODUCTION – DEMANDS FOR INTERCULTURAL COMPETENCES

Intercultural challenges in teaching have at most universities become increasingly visible over the last decades as growing numbers of students study internationally and more students have intercultural backgrounds due to immigration. However the basic point of this paper is that these challenges to engineering teaching goes beyond the classroom and must be seen from a broader perspective, as challenges in intercultural communication and cooperation are integrated into the professional profile and activities of engineers.

Cultural aspects of engineering

The intercultural challenges have been an issue in engineering for many years – or at least one which concerned the large number of engineers working internationally. They have acquired new importance as a consequence of the globalisation of education, industry, trade, and knowledge. They have also been evident in relation to problems of sourcing and implementing knowledge, innovation, and technology across culturally different settings. And in terms of culture embedded in technology, there is a growing understanding of the ethnocentric character of technology based on the recognition of its hybrid integration of social and technical elements.

While engineering has always involved the ability to adapt technologies to a given economic and institutional setting, this process of adaptation has usually remained implicit and ‘taken for granted’. Technology in general has been seen as socially neutral and therefore also independent of place. Consequently the implementation and adaptation has not been taken seriously either in the training of engineers or in the transfer of technology. However, engineering has never been a ‘culturally neutral’ endeavour, although technocratic visions and economic interests may have supported such an image. The contemporary professional practices of engineers are, largely, embedded in institutional configurations, national strategies, and cultural norms that define what is considered an acceptable solution and how different problems should be prioritised and solved [2,5]. Consequently culture is not an outside and contextual aspect of technology and engineering, but an intrinsic aspect of how these social interventions in societal development are produced and how they are part of ordering activities, infrastructures and divisions of labour in society.

Therefore intercultural challenges faced by engineering are not just a result of changes in the student population, and the cultural aspects of engineering disciplines and work challenges cannot just be treated as questions of identifying appropriate ways for communication and teaching. Indeed the teaching and the classroom become important settings for exploring aspects of culture in engineering work and for developing and intercultural competences [1]. Teaching has to pave the way for a more reflexive understanding of the ‘others’ and the professional ‘selves’ of engineers so that cultural difference is not merely turned into the only significant issue, and even more important that a professional vision is included in the analysis. Further the teaching must provide possibilities for developing the perspective of technology appropriation so that it can be complemented by a broader recognition of the contextual conditions for engineering practices and the attempt to develop and implement technologies in culturally different settings.

Approaches to intercultural aspects in the CDIO programme

So how does CDIO programme related to these different but interrelated perspectives on intercultural challenges in engineering teaching?

Intercultural competences are not directly addresses in the syllabus [3], but an ongoing discussing under the headline of internationalisation and mobility take up how to review and develop the CDIO programme in this way [8]. An international team have presented a discussion paper that provides background research, and this argues for the:

...growing need for international transparency in engineering qualifications, simple cross-credit processes, international dual awards and mechanisms to encourage student mobility. [8]

The discussion paper states that the CDIO Initiative:

... has a number of syllabus topics around internationalization: 3.3 Communications in Foreign Languages; 2.5.2 Professional Behavior; 2.5.4 Staying Current on World of Engineer; 4.1.6 Developing a Global Perspective. [8]

But it also states that neither these nor the 12 standards provide guidelines around internationalisation and mobility. The group therefore propose that the CDIO programme responds more explicitly in the syllabus by formulating an additional standard. This should underline that engineering education:

... prepares engineers for a global environment and to expose them to a rich set of international experiences and contexts during their studies. [8,p.7]

When addressing the cultural competences needed, Campbell et al focus rather explicitly on competences such as teamwork and communication skills. These are to some extent address in the Syllabus (3.1 about teamwork & 3.2 about communication). But as introduced above intercultural competences also need to be addressed as a basic condition and feature of engineering work. Here the existing CDIO programme actually provides important frames in the standards as well as in the syllabus for addressing the 'context in engineering' in the teaching.

A basic CDIO principle demands that the students require:

... an understanding of which includes such issues as the relationship between society and engineering, and ... a knowledge of the broader historical, cultural, and global context. [9]

Crawley et al. further develop on the context in engineering practise and teaching and they claim that

Engineering educators should be aware of, understand, and reflect on this context of professional engineering practice, and be prepared to make it the context of engineering education. [4,p.5]

By underlining the importance of context in engineering, the CDIO programme is criticising the growing focus on teaching engineering science that had developed in the 20th century reclaiming the 'poly techniques'. They concretely outlines a series of aspects of the professional context such as a focus on the needs of customers, a focus on the solution, not disciplines, working with others and effective communication, and they further states that:

... we should make students aware of the new and evolving elements of context, and incorporate them appropriately "sustainability, globalization, geographic dispersion and the human-centric nature of engineering practice. This is the idea that is captured in CDIO Standard One. [4]

Thus the basic principle of C-D-I-O and the elements of the syllabus are in line with this broader understanding of engineering work as basically contextual e.g. 4.Conceiving, Designing, Implementing and Operating systems in the enterprise and societal context. This has been made concrete in formulations such as: 4.1.4.The Historical and Cultural Context; 4.2.1.Appreciating Different Enterprise Cultures; and 4.4.5.Multidisciplinary Design.

The CDIO programme in this way does recognise the basic contextual aspects of engineering; however, it seems ambiguous that it still overlooks the basic cultural implications of the curriculum and the engineering profession. And even if the principles are stated, it is the challenge of the concrete engineering education programmes and concrete teachers to realise the methods, reflections and eventually learning on cultural aspects in engineering.

A basic point for Campbell et al. is that the CDIO programme may improve in this field by more explicitly creating a platform for students to learn important aspects of intercultural competences [8]. Along this line the case in this paper explores how such an intercultural setting can be used to develop such experiences and competences. Though the case we discuss the implementation of CDIO in relation to potentials and challenges of building authentic projects and close interrelations and hence develop the students' basic understanding of engineering as an inherently contextual discipline and the competences needed.

The structure of the paper is as follows. After this outline of our perspectives to understand cultural perspectives within engineering work, we describe how CDIO is implemented in the Arctic Engineering Programme and take out important lessons. In the third section we discuss the cultural aspects of the CDIO programme and of engineering work, and finally we conclude on the points to bring forward the CDIO programme in relation to cultural aspects of teaching engineering.

ARCTIC ENGINEERING – A DEDICATED INTERCULTURAL PROGRAM

The case relates to the development of a full - however small - programme in Arctic Engineering that frames intercultural classes in an explicit intercultural setting.

Since 2001 it has been possible to enrol in a special arctic Professional Bachelor Engineering education in Greenland. The programme takes place in Greenland and in Denmark enabling the Greenlandic citizens to start study engineering in their own region. The programme is anchored at The Technical University of Denmark and has two interrelated targets: (a) to train Greenlandic young people as engineers to take over jobs that today are carried out mainly by engineers from Denmark, and (b) to develop an arctic branch of engineering targeting the special features and challenges of this region. These challenges comprise of the extreme (and changing) climate, the geology, the vast unique geography with small isolated settlements, the fishing-based business sector, the 'double' cultural context of Greenland being a former Danish colony, and the need to support a social, economic and environmental sustainable development of Greenland. The Arctic Engineering programme not only mixes Greenlandic and Danish students, Danish and Greenlandic teachers but also faces the challenges of Greenland being an explicitly mixed cultural setting with which the engineers have to work.

Consequently the case frames rather explicit intercultural settings and learning environments opening for a critical discussion of different aspects of developing of intercultural competences. The implementation of the CDIO programme seems instrumental for the development of intercultural competences and for the development of a contextual approach to engineering. The teaching is now organised with a strong inductive approach and with focus on the special needs and the paper points to methods and lessons learned during the implementation of CDIO to address the challenge of intercultural learning in practice. At the same time the paper gives attention to the cultural bias of the CDIO programme that frames a series of more or less implicit assumptions that constitutes practical and necessary challenges in a modern and demanding engineering job.

Engineering education as part of a sustainable development of Greenland

The Greenland constitution has been changed by introducing home rule since 1979 and self rule since 2009 yet it is still involved in a National Community with Denmark. The large step towards a modernised society that have taken place since the 60's have been planned and carried out by Danish architects and engineers and based on the dominating functionalistic norms. The home rule has to a large extent focused on retrieving indigenous culture through language, art, and traditional hunting skills and identity. A parallel physical planning and institutional development have been sustained and improved dominated by perspectives on technology and economy from the government bodies in Denmark and the societal and industrial norms developing here. In short we can state that the former home rule emphasised the traditional cultural and language aspects of building and sustaining a local culture but basically overlooked the cultural implications of societal change and institutional planning and the importance of engaging in adapting the physical and technological development to the Greenlandic and to the Arctic context.

Greenland has a population of 56,000 inhabitants of which 10% are 'guest' workers from mainly Denmark dominating the management of most public and private sectors. Educating the next generations of Greenlandic citizens constitutes a major element of developing the home rule and the possibility of becoming an autonomous region within the global society. Thus, the aim of is to train engineers to handle not only technical tasks but also to engage in the development of Greenland's material culture, its social constitution and its economic development.

First step of the development of the arctic programme – a transfer

For various reasons, the Arctic Engineering programme was originally developed as a civil engineering programme anchored at DTU. After having completed the first 3 semesters with special arctic related courses in Greenland at the DTU micro-campus at the Building and Construction School in Sisimiut, the students move to Denmark to take standard engineering courses at DTU for another 2 semesters. Followed by a semester of work experience in a Greenland - or another arctic setting - they spend the last year with elective courses and make a final project focusing on an Arctic engineering topic of their choice.

The classes in the Greenland part of the program were very small until 2006. Approximately 10 students enrolled each year, and 1-2 students left during the first semester. Since 2007 the education seemingly has gained more attention among Greenlandic youth and 16-22 students have signed up each year including 25-33% Danes. The programme not only frames the meeting of Greenlandic and Danish students. The first group includes students with mixed backgrounds as there is a considerable tradition for mixed families in Greenland. The teachers are mainly visitors from DTU supplemented by a few local experts and consequently the teaching is in Danish

(Danish is the second language in the schools of Greenland, English is the third language) and it is organised in intensive teaching blocks lasting 1-9 weeks depending on the topic.

Although the intercultural situation in the classroom may seem obvious, this was not explicated in the first years. Neither was the curriculum regarded as an intercultural encounter. In the first curriculum the local arctic conditions for construction work and housing were only addressed explicitly with reference to the local geology and climate and living conditions. The general teaching in math, physics, and even in building construction science were related to the western engineering tradition at DTU with its traditional disciplines, approaches and ways of teaching.

From the very beginning it appeared that the teaching faced serious problems. This was confirmed by the fact that a much larger percentage of the Greenlandic students failed their exams than their Danish equivalents. From the perspective of the teachers this seemed to relate to some problems with the Greenlandic students: 1-4 of the Greenland students in every year group have very poor Danish skills; Some Greenlandic students are very reluctant to speak up in the classroom, to discuss, and to present their work; Some Greenlandic students display 'inappropriate study behaviour' such as showing up late or not at all, and failing to submit their assignments to the teacher and to their fellow students in group work. The 'inappropriate study behaviour' also caused irritation among the 'good students' and resulted in their reluctance to include 'the bad students' in the group work.

The problems outlined above have been discussed at great length among the teachers during the years. A series of different explanations have been launched based on more or less cultural simplifications such as a cultural lack of ability to abstract reasoning, a consensus based society that hampers the students in engaging in debates, and a colonial history of being governed. One fact is that the Greenlandic school system has severe problems of recruiting competent teachers and that the (relatively few) students that reach high school level face problems with coping at this level. A problem of generating enough trained teachers to the schools have grown since Greenlandic became the main language which excluded many Danish teachers. The teaching in the basic school system are developing, but most likely the students – as their parents – still experience a colonial knowledge dissemination embedded in the school system that feels estranged.

Most teachers in the Arctic Engineering programme focused on how to develop responding initiatives and these initiatives were traditionally undertaken by the teachers individually such as: personal phone calls to the students failing to turn up, focused support to some students, integration of more concrete cases in the teaching, and tests and quizzes to provide milestones. In this way one can say that the problems pushed the teachers to some degree to develop their teaching as the teaching 'normally' applied at DTU certainly was not adequate in Sisimiut. Basically most teachers experienced the problem as a dilemma between lowering the level to meet the relatively large group of 'poor students' and giving extensive teacher support on the one hand and preparing the students to the level and the teaching in large classes at DTU on the other hand.

Second step - implementation of CDIO principles

As the quantitative and qualitative evaluations of the programme as well as the teachers' experiences showed unmistakable patterns, a more basic and coherent strategy has eventually been launched that includes a more explicit strategy as regards the intercultural situation and the development of rather different didactic: Since 2007 a curriculum based on inductive teaching has been developed and teaching has been reorganised around what have been labelled 'composite

courses – large interdisciplinary courses each based on local contemporary engineering problems and tasks [10]. The aim of this is to encourage the students' motivation and ability to learn engineering concepts and methods.

The study plan addresses cultural aspects and development of cultural competences in different ways. Some initiatives take up the different cultural outset of the students and aims to build common platforms and visions of the study. One important point is that evaluations have showed that the Greenlandic students have very vague pictures of engineering work and hence what they actually are studying. E.g. there are not many Greenlandic role models and only very few of the students will personally know an engineer. Therefore the students are given a comprehensive introduction to studying and engineering. The first course integrates training in written communication, group work and project management etc., and the students have been offered personal coaching in order to reflect and develop their study behaviour. The following course explores engineering work e.g. through (telephone) interviews with engineers in Greenland – a growing number graduated from the Arctic Engineering programme. Also the students are trained in oral presentation and their own experiences in the class are discussed and related to the intercultural history - and future - of Greenland.

The intercultural dimensions are further highlighted as potential areas for developing competences that are called for in the engineering businesses. In this regard, the challenges must be unfolded and met by the students and the teachers in the engineering problems they deal with in the different interdisciplinary courses: How should e.g. building management processes be organized in intercultural working setting? How should the consequences of the imminent climate change for buildings and infrastructure be dealt with? How do we organize waste treatment in the stand-alone structure of Greenlandic cities? Which urban development is desirable and realistic in the sparsely populated country? And, finally, what is a sustainable development for Greenland?

The integration of the local context and local authentic engineering challenges in the teaching is regarded an important potential for motivating the students and to encourage student learning. In addition, it supports the development of professional competences including intercultural skills: Therefore teaching includes many study trips to see an ongoing construction, to examine a geotechnical phenomenon in the nature, to take samples, or to meet local professionals (most often Danes!). Furthermore, some courses engage in collaborations with the local government or technical infrastructure management in such a way that the work done by students in environmental planning contributes to the environmental action plans for the municipality.

The implementation of the CDIO approach seems to be instrumental for the cultural mixing in the Arctic programme – as well as other programmes - and for the development of a contextual approach to engineering.

First, most courses are interdisciplinary and start with an authentic local case, where the students can get deeply involved in the working of the local arctic societies – often in cooperation with local municipalities. Second, in accordance with the CDIO syllabus the programme [3] focuses on the personal competences. In addition to the group work which makes the subtle cultural differences clear to the students, special courses deal specifically with communication, building of networks, as well as the future job in a multicultural work situation. Even though the students like this form of education it also implies a higher stress on both groups of students. This provides a potential to acquire highly requested intercultural competences for both parties. However, it also constitutes a pressure on the teachers to develop new teaching methods and competences.

DISCUSSION

To sum up the development of the programme, the difficulties of integrating intercultural aspects in the first years of the programme to some extent can be related to the dominating natural science discourses being the core of typical engineering curriculum in which more specific engineering and non-science aspects are not regarded. Furthermore the unsuitable study behaviour of some Greenland students displayed that the teaching transferred from DTU 'did not fit all' and certainly it did not meet the intercultural challenges in the classroom.

From the technological point of view the inductive teaching of the new programme are much better at supporting the development of a new and 'contextual based curriculum'. This curriculum has the potential to address the challenge of how to put the local context - the values, cultures, conditions and competences – into play with the traditional professional knowledge and methods – and in the next section we discuss the challenges of the concrete programme as well as the CDIO programme and how this may improve.

The new curriculum further improves the didactics for the benefit of both Greenland and Danish students. However still a higher degree of the students from Greenland fail exams and leave the programme that is average experience at DTU. We still have to continue exploring the basic challenge of how to understand and benefit from the actual students and their different cultural and personal storylines and meet their 'learning culture' – while at the same time develop the students within the basic frame of teaching prevailing at DTU. In the next section we discuss the cultural bias of the Arctic Engineering programme and relate this to the CDIO programme.

The cultural bias of engineering teaching

The basic intercultural challenge in engineering work is that of 'transfer' – how to transfer science and technology to real life situations. This emphasizes the contextual dimension of engineering work and the importance for engineers to develop competences to analyse and meet the complexity of the different contexts that they work in, to go into constructive dialogues with other professionals as well as with end users and to be creative and develop new strategies and solutions.

The intercultural challenge to engineering work is in this context identified as fundamental to how engineering is taught. This is based on the observation that technology and engineering practices always have been developed in a specific cultural setting. This is often not reflected neither in disciplinary knowledge provided in engineering education, nor in the discussion about technology in society. Technology and the properties associated with it, being it the actors involved, are 'black-boxed' and taken for granted as part of the more general discourse on technological change and progress.

The need to explicate context is becoming more visible and engineers will have to learn to understand and handle the implicit social values and demands to the users and operators of the technology [4]. This leads to a new perspective on engineering emphasising its heterogeneous character in combining knowledge from different spheres – both codified in disciplines and non-codified resulting from experience, and with elements from natural sciences as well as social sciences [6]. A perspective that stays in contrast to popular, but newer the less incomplete views of engineering as either applied natural sciences or advanced technical skilfulness.

Development of a contextual engineering programme

This change is also present in the contemporary development of engineering education such as CDIO from being based on and dominated by scientific disciplines to include project assignments, team work, and new ways of assessing the weight between scientific and professional skills. As described in the introduction CDIO is responding to industry demands and include information gathering, communication, business management, project management, and ethical as well as professional responsibilities into the curriculum. After recognising the need for these competences, the challenge is to integrate the competencies, and depending on the specific engineering domain the integration of these new elements with the technological knowledge and experiences is what makes the engineer professionally competent.

Very often the cultural dimension of university training is highlighted in relation to the disciplinary practices based on safe, general and neutral scientific training. But in the case of engineering and the working with technology the professional practice is embedded in the division of labour in society and the organisation of production and regulatory institutions. The organisational unit, being it companies, government bodies or social movements, all work within established hierarchies of norms and managerial power. These hierarchies also define boundaries at which the differences in values and norms potentially create tension between e.g. scientific approaches to problem solving compared to the conditions for practical problem solving. Also societal discourse – which may indeed reflect deeply rooted cultural norms in the forms of visions of development and progress, ethical values on human behaviour, and religious beliefs – has important impact on the conditions for professional practices.

As in the case of environmental management, which is a topic in one of the courses, where the students are to develop a strategy for environmental management in a housing area or in the local city, the social acceptance and standing of science based knowledge very often is confronted with the economic and managerial demands of a hierarchical and private ownership based decisive power in companies. This problem may be seen as rather generic and independent of the cultural norms inside the engineering community and of the cultural embedding of professional practices, government regulations, and the role and power of leadership in business. It even is part of a globalising discourse on sustainability. Still the specific values and assumptions are crucial for how it is possible to negotiate and implement changes in companies in different countries and with different dominant management strategies. Here the differences may sometimes be ascribed to e.g. cultural differences in valuing nature and social condition for human life, but these can as well be related to differences in management styles as to the ethnic background of the owners. The interpretational flexibility of the professionals engaged in intercultural cooperation is important to avoid falling into simplistic explanations featuring prejudices and limiting the possible actions that might lead to change.

This even shows more visible as engineering problems typically are not well defined – sometimes even wicked – from the outset and relevant solutions are not easily picked from an unquestionable catalogue of science backed solutions [11]. An important part of engineering work is in fact about the identification of the problem as well as mapping the possible, often multiple solutions before getting stuck with existing problem definitions and problem solving strategies [12]. Another important element typical for environmental engineering is the need for creating a sound, but still negotiated ground for action instead of waiting for science, government regulation, or customer demands to set the agenda for change.

E.g. the process of discussing realistic solutions for environmental management while having to accommodate both the users, the indoor climate, the environmental demands and the available

technology and economy will support the competences among the students satisfying the aim of making them become 'heterogeneous engineers' [6]. In principle, the Arctic Engineering programme is also more open to developing contextual technological solutions and approaches than traditional discipline oriented teaching.

The cultural dimension of teaching and learning

Educations represent organised settings where often different expectations to the content of the field, the role and form of teaching, and the appropriate students' behaviour are present among the students and the teachers. Most often these understandings are not very visible [13]. On the contrary at universities seems to be a non-spoken presumption that everybody knows what the field is about, what the aims of the study is, and how the study and learning should be performed. To complete the education means to be able to act in relation to these understandings and basically to assimilate them. Hence it is presumed that the students actually share the understandings, the approaches, and the values of the educations and their perspective on the profession.

At DTU the students are basically expected to be personally ambitious as well as development and product oriented. In the case below this shows to be of vital importance and the intercultural settings in the case of course put the implicit cultural and subjective understandings under pressure.

This case provides an example as the difficulties must also be related to more basic cultural and social aspects of the Greenlandic development. The home rule – as well as the teachers - sees the programme as an important contributor to develop local intellectual elite in Greenland. However this aim might not be mirrored in the students – the potential elite. While motivation is a basic feature of most modern approaches to learning, motivation seems to a more complex issue in the Arctic context. Most Greenlandic students that do well express ambitions for their personal carrier and a few students express ambitions of contributing to the development of Greenland. This attitude fits very well with 'the western individual identity' and the teaching in the programme is made to match the correlated - however implicit - image of such a student [13]. However evaluations of the programme indicate that the students that mismanage are not motivated to study engineering – or study at all. Some explain that they choose the programme because it was located in Sisimiut, others that they just 'ended up being enrolled'. We get the impression that they do not relate very much to the idea of being educated. And the alternative - not being educated - is very visible among their friends and families - and they manage, so....

The lack of individual ambitions- or different ambitions – of some of the students – that seemingly mirrors a larger part of the population - are often related to as a cultural aspect of the indigenous consensus oriented culture and by living from day to day – perhaps enlarged by many years of colonial paternity. The Greenlandic society has changes substantially in the last 5 decades including material culture, values and lifestyles. It seems though that the 'different' ambitions of some young people challenge the dream of developing Greenland as an autonomous region in the global developing. It raises a much broader question of how to motivate Greenlandic youth to study and to engage as citizens in the development of Greenland?

This is along the line of the general development strategies of Greenland that are transferred rather uncritically from the European not leaving much emphasis or potentials to the Greenlandic context. This also goes for the educational strategies. CDIO very clearly has a cultural bias as it represents a western approach to personal development and does not reflect other ways of 'becoming and being an engineer'.

The teaching and the development of new work forms frames new implicit understandings of knowledge, learning processes and scholarship – and of the student. The implicit student is not a conscious perception of the institutions, the teachers or the students on the role of the students, but that which becomes present through structures, codes, norms and cultures [13]. An analysis of the implicit student in the engineering educations includes both the above traditions and perceptions of the engineering profession as well as the educational structure, the flow of educational elements, the teaching and the work forms as well as the relations between the participants.

The traditional teacher centred courses are characterised by a high degree of teacher control in the choice of topics, materials, assignments and progression. The project oriented approach of the CDIO is in itself a new ‘technology’ that is being transferred from different cultural settings as shown in the case below. The Arctic Engineering programme is characterised by a higher degree of student participation and control in formulating the problems to be solved, in the methodological approaches, and in the organisation of the work – and most often by group work. This calls for a new series of skills such as self management, work together in groups and collect and use knowledge critically. The project and hence more context oriented work also means that the students has to work with knowledge as flexible and to combine scientific knowledge with other and very different forms of knowledge - perhaps carried by other professionals or end users. Still the teachers are controlling the basic defining of the subject and the assessment criterion; in practise though the supervision and the assessment. The implicit student in the project work must then have skills to translate the often more diffuse codes within the supervision to assess and progress the work [13,p.55].

CONCLUSION

The standards and principles of CDIO tend to focus on rather instrumental competences when addressing the intercultural aspects of engineering. These include communication, language and cultural insight as a context that does influence the conditions for implementing technology but not change the fundamentals of engineering seemingly independent of cultural conditions. The role of intercultural insight is to make the basically revolutionizing and development producing technology to work in the specific local context.

This contrasts the national, class related and infrastructure specific parts of technology otherwise identified as core to the foundations of engineering practice e.g. concerning the role of technology in relation to the foundation of state, power and the organization of production. In a country like Greenland where settlements and towns exists in distributed structure of economic and infrastructural islands and where land is not privately owned but organized as a collective good that for periods of time can be lent to specific types of use the societal conditions for building technological infrastructures and use the natural resources demands different technological solutions as well as different institutional structures to handle the vital common facilities and to plan for the impact of climate change and global involvement in new industries like mining and oil exploration.

Also the cultural embedding of teaching and learning principles as well as the creation of individual professional identities in a classic collectivist culture where social dependency is the rule, not the exception raises serious challenges to be overcome in the way educations are organized.

CDIO therefore needs to reflect the cultured character of technology itself and the way engineering is defined as part of a hierarchical and commercial as well as institutional national systems not necessarily to accept these frames and contextual conditions but to be able to reflect them when problems are addressed in different cultural as well as nature influenced settings.

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