

TEACHER AND STUDENT INTENTION AND COMMITMENT IN A CDIO CURRICULUM

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ABSTRACT

The purpose of this paper is to highlight and discuss the impact of culture as a powerful outline for how to think, feel and act. Norms and routine acts are taken for granted and guide individuals as well as the organisation. In 1999 Linköping University started a collaboration between MIT, Chalmers and KTH with the aim of developing engineering education. This was the start of the CDIO initiative. In 2002 the first cohort of students in the study program of Applied Physics and Electrical Engineering (Y-program) entered into a program designed to meet the requirements of a CDIO syllabus.

In this study recurring interviews with ten Y-students between 2002 and 2007 and a focus group interview in 2010 with lecturers in the Y-program are used to discuss the following questions in relation to a selection of program targets:

- Students entering a study program have some expectations of what studying is and what the study environment will demand from and offer them. How do they express this during their period of studying?
- How do teachers express their expectations of the students and of themselves as teachers?
- Within the context of a specific study program, the Y-program, is there an alignment or a dissonance between the approaches to learning and studying expressed by the students and the approaches to teaching and learning, as expressed by the teachers?

Our results indicate that despite the curricular changes made between 2002-2010, both students and academic staff experience that the changes made, i.e. CDIO project courses, are joyful and useful but that these are not integrated into the “real courses” or regarded as “true teaching”. The norm of how to design and carry out the basic structure is strong and in the discussion we argue that this might be upheld by values in society, of Engineering as a solid male/masculine culture, where females find difficulties in adjusting, or changing the culture and therefore take on different paths or exit and leave the programme.

KEYWORDS

Approaches to learning; approaches to teaching; study culture; expectations; socialisation. Intentions.

BACKGROUND

In 1999 Linköping University started a collaboration between MIT, Chalmers and KTH with the aim of developing engineering education. This was the start of the CDIO initiative. In 2002 the first cohort of students in the study program of Applied Physics and Electrical Engineering (Y-program) entered into a program designed to meet the requirements of a CDIO syllabus. A CDIO project course was introduced the first semester and an elaborated

project course delivered in year three and a build-design course in year four. In a longitudinal study four cohorts of students, starting in 1998, 1999, 2000 and 2002 have been monitored on a regular basis throughout their studies, in order to see what their expectations were when they started, their experiences of their studies and their reflections on their studies after graduation, in relation to work and employment [1]. This study had a focus on student experiences in relation to the intentions in the curriculum and the CDIO syllabus. In 2007 the study was completed, but we are still working with the material, especially the longitudinal interview material. In 2007 the new degree structure of Bologna was implemented in Swedish higher education. This required teaching staff and administration to redesign course syllabuses and program documents with a focus on learning outcomes [2]. From 2007 there has been a growing interest in pedagogical issues among faculty and students, and the alignment between intended learning outcomes and examination has been highlighted with a focus on the meaning of “teaching” in relation to student learning. In 2010 a focus group was set up with academic staff who at the time were teaching in the Y-program. The aim was to have the teachers to talk about what “teaching” meant to them and have them express their experiences of being teachers in the Y-program. They all had long experience of teaching in the Y-program as well as in other study programmes.

In this paper we combine these data, longitudinal interviews with ten students who enrolled in the Y-program in 2002 and the focus group interview with senior academic staff in 2010 who had experience of the implementation of the CDIO syllabus as well as of the Bologna reform.

THE PURPOSE OF THE PAPER AND RESEARCH QUESTIONS

The purpose of this paper is to highlight and discuss the impact of culture as a powerful outline for how to think, feel and act as well as a web of conceptions and ideals [3] Norms and routine acts are taken for granted and guide individuals as well as the organisation and thereby save energy and facilitate interaction and communication, as people “understand” each other without having to make things explicit and without arguments. Culture is enacted through processes of normalization and subjectification [4], processes where individuals create themselves as distinct kinds of subjects through self-perception *and* signals from significant others. People within an organisation are encouraged to define themselves as the kind of people who are suited for the organisation and “chosen” for this kind of tasks. This definition produces a standard to which subjects commit themselves [3].

The Swedish government has commissioned the “Teknikdelegationen” (The Delegation of Swedish Engineering) to map all initiatives aiming at increasing the interest in science and technology among children and young adults, with a focus on females. The purpose is to prevent a gap between supply and demand among engineers when many baby boomers retire [5]. In 2009 a report was published [6] where the Swedish engineering educations in Electrical engineering and Mechanical engineering were monitored by the Association of Swedish Engineering Industries. One conclusion in the report is that there are different opinions on what the “core content” of a Master of Science in Engineering should be. The employers focus on “solid and traditional engineering knowledge and competences” while academics focus more on disciplinary and generic competences. One conclusion is that teaching and content should be more aligned with work-life demands, i.e. more project based and work based learning activities and it should be easier for students and employers to understand what a degree means and what can be expected from a graduate student.

Despite curricular changes, marketing efforts and branding, there are difficulties in attracting and keeping engineering students, especially females, and the questions we ask in this paper are related to the study culture of the program.

- Students entering a study program have some expectations of what studying is and what the study environment will demand from and offer them. How do they express this during their period of studying?

- How do teachers express their expectations of the students and of themselves as teachers?
- Within the context of a specific study program, the Y-program, is there an alignment or a dissonance between the approaches to learning and studying expressed by the students and the approaches to teaching and learning, as expressed by the teachers?

METHOD

For the purpose of this paper we are using two different data sets. One set is the student interviews collected within a large, longitudinal study [1]. The other set is a focus group interview with 5 academic staff [8]. The student interviews cover a period of six years, 2002-2007, while the focus group interview was made in June 2010. Between 2002 and 2010 there has been curricular as well as organisational changes in the Y-program and the intention was to see if these changes also had changed the way students and staff experienced and talked about the quality of the program, about teaching and learning and the identity of the program.

Both sets of data have been analysed in relation to four selected qualitative targets for engineering education [7] (our own translation into English).

- 1) Knowledge and understanding: show a broad knowledge within the chosen field of technology, including knowledge in science and mathematics, as well as considerably deepened knowledge within specific fields.
- 2) Skills and competencies: show an ability to identify, formulate and manage complex problems in a critical, independent and creative way with a holistic perspective and be able to participate in research- and development work and thereby contribute to the development of knowledge.
- 3) Skills and competencies: show an ability to work in team and collaborate in diverse groups.
- 4) Judgements and approach: show an ability to make judgements based on relevant scientific, social and ethical considerations and show awareness of ethical aspects in research- and development activities.

Student interviews

In this paper recurring interviews with ten students are used [1]. Five male and five female students who enrolled in the Y-program 2002 were interviewed, twice during the first year and after that once a year until graduation, or until they left the program. The interviews were conducted between 2002-2007. For the purpose of this paper the interviews have been read through and reanalysed with a focus on the students expectations of the study environment and of their achievement when they started; their approaches to learning and studying and their experiences of the study environment during their studies.

There were in all 26 interviews with the male students and 15 with the female students. Three of the five female students dropped out or made longer periods of study leave in combination with work and they were not able to participate in the study to the same degree as the male students.

The analysis of the student interviews generated five themes:

- Approaches to studying and studies
- Experiences of course/program design
- Study strategies
- Approaches to teachers and teaching
- Identification with the Y-program

Focus group interview

In the beginning of 2010 the Chairman of the Program Board for Electrical Engineering, Physics and Mathematics was contacted and informed about the project and asked to recommend a number of teachers that would fit the criteria of teaching in the Y-program at present and with some previous experience of teaching in higher education. He was asked to suggest male as well as female teachers to be interviewed.

Ten teachers were addressed via an e-mail in which the project was described and they were asked to sign up for a participation in the study. Five persons accepted the invitation, one female and four male teachers. They all have some experience of the CDIO syllabus, but they also teach in other engineering programmes where the CDIO syllabus is not so evident.

The teachers received a “welcome-letter” where information about the study as well as practical information was given, for example time and place for the focus interview.

The study took place in June 2010 and was conducted at the Centre for Teaching and Learning at Campus and lasted for about two hours. The entire interview was recorded and later on transcribed entirely.

The method, focus group interview [8], was chosen since it would admit the teachers to interact as a group while describing their experiences of teaching at the Y-program.

In the beginning of the interview the teachers were informed about the aim of the study and also about the method to be used. The question in focus was : How do you perceive teaching in higher education according to your experiences and what is your approach to student learning and teaching in a Master of Science in engineering at LiU, namely the Y-programme.

During the interview questions concerning “how we do it” tended to be in focus rather than discussions about what teaching “is or might be”, in a more philosophical sense. Throughout the interview the teachers made references to the targets for engineering education, although without explicit wordings. Instead they talked about what competences a Master of Science in engineering should develop during the educational process. The main focus was in what way their teaching could contribute to this.

The transcribed interview was read through several times. The analysis generated four themes, with a focus on the competences related to the emergence of a graduate engineer.

- a solid ground in mathematics, natural sciences and technology
- the problem solver
- the communicator
- the scientist; with characteristics such as autonomy, critical thinking and creativity

The data was analysed based on the group as a whole. The results that will be presented in the next section of this paper will mainly be illustrated by an assortment of quotations chosen with the aim of illuminating the variation among the experiences expressed by the teachers in the group

THEORETICAL CONSIDERATIONS – PREVIOUS RESEARCH

Key concepts used in this paper are *intention* and *commitment*. The concept of intention originates in the works of Husserl, who was a mathematician who became a philosopher whose work is about how to understand how people make sense and meaning of the world. For Husserl intentionality means that human thoughts and actions always are directed towards something, an “object”, we are always part of the world, even as researchers! Within this broad, epistemological framework we give meaning to the concept of *culture* [3] that derives from organisational studies, indicating that there are norms and routine acts that are taken for granted and that these guide individuals as well as the organisation. It is when you

are a newcomer you sense the culture, in what is defined as “normal” or “deviant”. People who are within a culture think about themselves as “we” in relation to “the others” and they tend to commit themselves to the culture and identify with its values. Another concept used is the concept of *subjectivity* [4], a process where individuals create themselves as the kind of people who fit in (or not), in response to their self perceptions and the perception of significant others. This culture is enacted in the design of the study program and the ways of thinking and practicing the subjects taught [9, 10; 11; 12]. Ulrichsen [13] argue that the structure of a study program, the modes of teaching that are applied and the teachers’ expectations and experiences all have implications for the students. In a study he showed the contradictions and ambiguities of both students and teachers in a study program in science. The taken for granted, unspoken anticipations about what studying is and the meaning of studying contributed to teachers’ frustrations of uncommitted students as well as to the students opting or dropping out. The concept “the implied student” indicates that there is a structure, inherent in the way the study program is designed and carried through, but it is also a structure of action in the sense that students and teachers “do” the study in particular ways, in their actions. Knewstubb and Bond [14] introduce the concept “communicative alignment” to describe similarities and differences between the teacher’s intentions and the way the students perceive the lecturer’s intentions.

” If beliefs about knowledge, teaching, learning and the subject were treated as part of the interpretive context of teaching-learning communication, it might be possible to develop models that integrate the conceptual and communicative elements vital to higher education” [14].

Becoming a Y-student, and being a teacher in that programme, means complying with, or relating to, a set of cultural and disciplinary cultures [13] but different persons have different possibilities and restraints in their way to “perform” their positions as students and/or teachers, depending on gender, cultural background and professional goals as well as on the organisational culture. Women, in a male/masculine culture, have to perform their positions in a different way than their male peers [15]

Key concepts in this paper are *approaches to teaching and learning* and in elaborating on the intentions and commitment of students and academic staff we are using the concept of “Quality of learning achieved” [9] where the concept of “*student learning*” has been broadened, from a main focus on conceptual understanding to the covering of additional skills and ways of thinking, both academic and professional, referred to as WTPs (ways of thinking and practising in the subject). Within a specific subject area, i.e. engineering, crucial topics or concepts are identified and the difficulties identified by students and teachers are conceptualised as troublesome knowledge [16] threshold concepts [17] and delayed understanding [18]. The ways *teaching* is carried out depend on the collective pedagogical WTPs of teachers providing it, but also by institutional priorities, the teaching ethos of the department and the outside influences coming from the academic community as well as from validating bodies and student expectations [9].

In order to understand why some people adjust and comply to the norms, while others try to influence, change and develop it and some people exit and leave we use the concepts of *dissonance and friction* [19; 20 ; 21; 22], indicating that people whose expectations and values are *not* aligned with those prevailing tend to experience some kind of dissonance or friction. These can contribute to development and change, or they can contribute to compliance and/or exit and withdrawal. In line with this there is the assumption that the way people act converge with their intentions, their goals and motives for wanting to stay. According to this, within a specific culture, people can stay and adapt to the culture either as a necessary evil, trying to survive, or because they identify with the culture and want to be a part of it.

RESULTS

The results will be presented in three parts. First the results of the student interviews and after that the results from the focus group interview and finally the result when these are integrated and related to theoretical frame works.

Student interviews

The five male students all completed their studies, although within a time span of about two years. One student became a PhD student and one worked as teaching assistant at the end of his studies. Although their study motivation failed at times they kept a stiff upper lip and finalized their grade. The five females and their responses as well as their study trajectory differed from the males. Three of them described themselves and their studies as a “disaster”. They tried to compensate periods of lack of study motivation with engagement in other extra curricular activities and/or social activities. This in turn contributed to delays in their study pace and in 2007 they had not yet graduated. The female students commented on the harsh culture, feelings of military camp and experiences of hostile lecturers. They also commented on the benefits of being different. As females they were noticed, their names were remembered and they felt free to ask “silly questions” in class and in private to lecturers. Both male and female students express themselves in the themes and citations are chosen to show the variation of expressions. Where there are obvious gender differences this is commented in the text otherwise “students” indicate male as well as female students.

Approaches to studying and studies

The students approaches to engineering studies are expressed as a solid interest in the subjects, mathematics, physics and technology, and an aptitude for that kind of studying.

“I believe I have a natural aptitude for this kind of studies. I have always managed very well at school...and it is fun to study...fun with mathematics and physics”

They emphasise that their interest is not primarily to strive for a career as an engineer, as they have very vague ideas of what this means. Their interest is in studying, being students, learning and achieving.

“The attraction was not a career (as engineer) but the challenge..”

As the Y-program is considered to be a tough program, the challenge of managing this as well as the prestige and pride to be part of this community, are driving forces.

“The Y-program is quite famous and to graduate from that has some prestige”

This makes it quite hard for the female students who “failed” during the first years and therefore lost their self confidence for a while and either compensated this by engaging in extra curricular activities or dropped out.

“At times it has felt like a waste of time and I really have been a failure and my self confidence is low...but I really want to study in this program”

The students approaches to studying were also expressed as based on some inherent, personal characteristics, i.e. being competitive, achievement oriented, ambitious and talented. They did not work too hard in secondary school to keep up a reputation of being among the best.

The approaches to studies and studying are based on the students general interest in studying and their solid interests in subjects like mathematics, physics and technology. They seldom talk about engineering as a profession or about engineering competencies and some of the students even express a fear or disdain of work life, in relation to studying.

“...to be honest, it frightens me more to get out on the job-market, than it motivates me”

Experiences of course/program design

During the first years the students describe the design of the program as fixed, with compulsory classes that has to be attended to and exams to be passed in order for them to be able to be eligible for the last years when there is more freedom of choice.

“ They (faculty) told us from the start we know what we teach you and everything is planned in detail....but it has been very one-sided, a lot of maths and stuff”

“It is very well thought through, how we go through the foundations, step by step...but I guess I will not use all this knowledge...with some of it, you have no idea what the meaning is”

The opinions of this design is ambiguous. The program structure is talked about as “a necessary evil”, something you have to endure, manage and survive and if you do you are among the smart and successful students who can later choose courses out of interest. The price they pay is a loss of the interest and passion for the subjects that some students had from the start, and a disappointment when they find themselves adapt to a study behaviour where they just do what they are expected to do without thinking and/or reflecting. This was most outspoken among the female students. After the first two years they justified the design which they now realised provided them with the knowledge and skills necessary for their elected profile courses.

“Now (year 3) we are taking more applied courses and that is what interests me, things I enjoy like space research, mathematics, electronics and the like...you can not change the program and make it easier because this means lowering the quality”.

“The courses are more and more related to reality...you get a sense that they have something to do with what you are going to work with in the future”.

Some students had tried to influence the overall structure, but their efforts were met with arguments that “this has always been done like this”.

During the first semester and in year three and four they had a CDIO project course. All students said that these courses were interesting and fun although very time consuming. They mentioned that it was in these courses they learned to collaborate, work in teams, leadership, communication and to apply their knowledge in a real, complex situation.

“It was really fun! So different from everything else we have been doing, all the theoretical stuff...now we could *do* something and apply our knowledge”.

Despite that, the experience that they learned a lot and put a lot of effort in their work, they did not consider this to be a “real course”. It was a benefit, a project that “stole” precious time from “the real courses”. They also talked about the CDIO courses as “breaks” from mathematics and other hard stuff. Project work was associated with pleasure and within their own control and therefore did not count as a “real course” or “true teaching”.

“It was a nice break because I am so tired of studying for examinations...and finally you can apply what you have been studying, ..it is so much more fun”.

“It was a break from the ordinary studying, to build these robots... it is a bit more like engineering”.

One suggestion the students had was that the whole program should be more project based, but they commented that it would be impossible as they would not be able to cram in all the necessary course content.

Study strategies

All students had the *intention* to manage the program and graduate, but they used different study strategies to achieve their goals and they had different experiences about the price they were willing to pay to manage. Both male and female students preferred to study for the examinations on their own, in solitude.

“ I need time to calculate, think over and think through things before I discuss with others...I do not want to have my line of thought disturbed before I am

ready”.

Female students preferred to study with friends to a higher degree than male students.

The study strategy during the first two years was to attend all scheduled activities, to plan everything and discipline themselves. Female students commented that they also wanted to have a life outside the university, and that they at times gave priority to friends and family. The price they paid was that they lacked behind, could not keep up the pace. To attend lectures, go home and drill all stuff into their heads was the way they worked, in order to understand what they were reading in their traditional courses. They have a different approach to their project courses where they work in groups and learn to plan and manage their time and to collaborate. They also have another approach to the way they study their elective courses (year 3-5), when they take control over their ambitions, study pace and ways of studying. One female student, who has taken control through designing her own study path and eventually was doing very well, commented

“ I do not think I have become smarter over the years, it is just that I never had time to reflect on anything before”.

Approaches to teachers and teaching

The students do not talk about their “teachers”, they talk about *lecturers* who lecture in big halls for 100-200 students.

“You do not have much contact with lecturers and a bad lecturer makes you loose an interest in the course....a good lecturer can explain and talk so you can understand and a bad lecturer does not engage in the lecture and does not care who he is lecturing for”.

In smaller classes they have “lesson leaders” and they elaborate on the lectures and the students can ask questions and get supervision. A good “lesson leader” is helpful and a good listener.

“The lecturer go through the stuff, rattles off what is in the book, and demonstrates it. If you do not understand, it is the role of the lesson leaders to help”

Then they have labs where senior students or PhD students assist and answer questions.

A general opinion is that teaching staff know their subjects but that their attitude to the students and teaching skills vary and the students are more satisfied in year 3 and 4 than during the first two years. Male students are more impressed by the quality of teaching staff than female students.

“I think they are good..they know their stuff...they are quite tough and self-assure, a bit like Arnold Schwarzenegger”.

Female students comment more on the attitudes and the masculine setting and tough climate.

“ I have been very upset with some teaching staff...very hostile to females..you do not want to ask him questions because he makes you feel stupid..he is well known for this but he is good at his subject”

Both male and female students comment on the age of the teaching staff and appreciate younger persons.

“The feeling is that the older ones should need courses in pedagogy...maybe they just want to do research instead of teaching...it is as if they do not really have time for us”

The students appreciate teaching staff that they can talk to and understand and who are committed and helpful.

Identification with the Y-program

Being a student in the Y-program means that you acquire skills to solve problems and think analytically. As it also is considered to be a tough program, where the demands are high, graduating from the program gives a professional self confidence to those who have passed

and graduated. There is a gradual selection during the program, as one male student commented “ you sort of get cast in the same mould”, while one female student expressed the feeling of identity as

“ it is a bit like being in the military services...it is a very strong feeling that it is ` we´ against ` them´ and ` we´ are the best!...I find a lack of reflection and thoughtfulness among these people...nobody talks about what we are doing with our knowledge”.

They describe the quality of the program as a formation of character, and in order to succeed you need a proper foundation, i.e. students who are “a bit special”, nerds, who like to keep to themselves, self-disciplined, ambitious, able to manage everything, have a passion for mathematics and are *very* smart. One female student comment on her own description by saying that “they really *are* very smart and can manage *anything*... a kind of superman”...but at the same time she claims that when you are part of this community you realise that they are “ like everybody else´, young people who like to party and have their ups and downs”.

The students also reflect on this image in relation to their own characteristics and identities and come to the conclusion that this is what potential employers look for

“ they say that the profiles really do not matter so much, it is the fact that you have graduated from the Y-program, that you are a Y-student that matters when it comes to employment”.

Focus group interview - Teaching in a Master of Science in engineering.

The teachers talked about the teaching they conduct in three different ways partly depending on the situation and the group of students they were teaching. An example of the first approach, where the role of the teacher was described in terms of transmitting knowledge to many students simultaneously, is illustrated by the following quotation

“You mediate lectures and knowledge in a strictly structured and digestible way to help the students collect information”

Another approach is illustrated in the following, now with the focus on motivating the students

“I don´t just stand there telling them things expecting them to listen and that´s it. What I´m trying to do is to make them enthusiastic, make them feel it´s fun. They are the ones who have the ability to learn, however not by me. Once you´ve got a person interested in something all other problems are solved”

A third way of talking about teaching illuminates the fact that learning and teaching can be conceived as a process of progression

“There is an enormous progression during the educational process, the way you treat the students, your attitude towards them.....from being a nanny to treating them as highly competent adults”

Among the teachers in the focus group there was one opinion that they all shared and that is what teaching “is not about”, related to the way it is conducted. What might be described as teaching activities is not always what they perceive as true teaching. As they lecture in front of a large group of students they do not teach in a true sense, they lecture and that is all. Thus they make a distinction between their role as lecturer and supervisor and illustrate in what way this can restrict them in their teaching efforts. They described true teaching as taking place when there is some kind of two-way interaction between the teacher and the student, for example during lessons, supervision or lab-work.

“When there is an interaction, a reciprocal relation where both parts get stimulated intellectually”

“When you are supervising and meet the student over a longer period of time and you can see a progression and you say to yourself: ‘Shit, he wouldn´t have managed to work this out one year ago!’. Being part of this makes you feel that you really are a teacher, you´re part of the process, so to speak ... you share the experience”

“When you really feel that you are a teacher is when you sit and talk with one or two students and try to explain things and all of a sudden you can see that they have understood something”

“When I give a lecture and stand there talking in front of 250 students, then there is no interaction, although I am a teacher in a formal sense”

The teachers talked about the CDIO syllabus as a supplement to the fixed design which they described as “traditional teaching”, i.e. with lectures followed by lessons and lab work and finally the individual written exam. At the same time they described the interaction between the teacher and the students during project work as outstanding in a qualitative sense. Now and then the teachers commented that CDIO has changed things

“There have been many changes on the Y programme, not because of Bologna but by introducing CDIO-courses”

“Maybe the culture is changing as an effect of CDIO”

The female teacher mentioned that there is a problem worth mentioning and that is that there are so few women attending the Y-programme. She described it like this

“There are no role-models for the girls. When you discover that all the teachers are men and that the rest of the students are men you realize from the very beginning that you won't have a chance here. And then the smart girls will choose another programme”

One of the male teachers made a comment on this

“I don't think there would be a different culture on the program if there were more girls there”

While listening to her male colleagues describing traditional teaching on the Y-program the female teacher now and then asked them

“What will the teaching that you conduct lead to? What will the students become? “

The first answer, which came up immediately, was

“They will become problem solvers”

One of the teachers expressed his intentions related to the modes of teaching that he has adopted in relation to a new generation of student:

“Fifteen years ago they (the students) didn't ask questions like ‘Why do we have to learn this?’. They trusted the teacher and if he said that this is important they figured it to be important. So I have changed my way of teaching today I have to motivate them”

Focus group interview - To become a Master of Science in Engineering

During the interview topics concerning the students were in focus to a large extent; who they are and what they are to become, i.e. Masters of Science in engineering. The following presentation is built on four themes that were emerging during the analysis of the data from the focus group interview.

A solid ground

All teachers stressed the importance of helping the students to develop a solid knowledge base in mathematics. They also shared the opinion that this should be a main task in the early stages of the study programme. When they discussed in what way teaching could contribute to this effort there were two different approaches emerging. One of the teachers described the way in which the teacher's knowledge in the subject can be transmitted to a large group of students simultaneously.

“By lecturing, the teacher's experience of the subject and its structure is transmitted to the students. It constitutes the fastest way to gain knowledge in the subject area at hand. It's a way to rationally and in a short period of time become acquainted with a subject and gain crucial knowledge. The role of the teacher is to make the learning

process fast and rational”

Another teacher described student learning as a process where knowledge is developed by the student herself and where the teacher’s role is to facilitate understanding.

“I want the students to understand what they are doing, not just gaining some knowledge on the surface, memorizing without understanding. The thing is that mathematics is what I am up to and when it comes to mathematics understanding is fundamental. I would rather prefer more limited knowledge within a field as long as the students really understand what they are doing”

The problem solver

During the interview the teachers often talked about the students in terms of “engineers to become”. They stressed that these students are to become problem solvers who are able to identify, structure and solve any problems that they will face as engineers.

When it comes to how these competences might be developed there were different opinions among the teachers in the focus group. Some of them described their teaching as a shaping process where the students step by step develop problem-solving competences.

“You can see it during the lessons where you as a teacher can make a good example to the students by initially writing explicit and well structured solutions on the white board while, after some time, just giving them an outline with the details implicitly assumed. The balance between these two strategies varies according to how far the students have come in their studies”

Some teachers stressed the importance of letting the students implement their knowledge even at an early stage by working in a more hands-on way and thereby develop their problem solving abilities as well. One example of this is an utterance from the female teacher when she stressed the importance of letting the students themselves find out what kind of knowledge they need to solve certain problems

“CDIO has refreshed the program a lot and made it more vital. You get a chance to apply your knowledge in a way that was not so common earlier I conceive these CDIO-courses as very positive since you can bring something from the research area into teaching once the students ask for it as they themselves have discovered the need for this kind of knowledge to be able to solve their problems”

The communicator

Those of the teachers who work at the early stages of the program described this as a challenge, since the students on the Y-programme constitute a rather silent group. On the other hand most of the communication between the students and the teachers take place via lab-reports and written exams. It is to a large extent up to the teachers and the students to decide about the amount of interaction and the kind of interaction. Later on in the program there are more opportunities to meet and interact in smaller groups as well for the students as for the teachers, for example during supervision sessions or project work.

Many times during the interview the teachers stressed the importance of skilled interpersonal communication for the Engineers to become. They described it as a relief that there are project courses integrated into the program (CDIO-courses) since these courses build on interaction and communication and thus should contribute to the development of related skills and competences. The following citations describe the dilemmas that the teachers experienced

“The students on the Y-programme are quiet. They have always been and will always be like that”

“I think it is quite hard with a group of Y-students, to make them ask questions. They are rather quiet. However, you can see that they sit there thinking about something and then you’ve come a bit further in your teaching”

“They will have to work together in groups, discuss and manage the task. They will have to interact (on CDIO-courses). That’s one of the reasons why these courses

have become so popular, I believe”

“I don’t think it has changed our way of teaching but with *supplements* like these the students will develop new competences like planning, organizing, writing and presenting”

The scientist

The teachers described many students as autonomous, with creative and critical thinking abilities already at an early stage of their studies. However, these talented students are often rather quiet and prefer to work on their own to a large extent. The teachers in the study asserted, with a smile on their face, that these students manage very well without taking part in any teaching activities.

“Students on the Y-programme who sit and work by themselves during the first years at university are potentially interesting people to recruit for PhD-studies. They are extremely intelligent, competent and independent students. However, you have to make them start talking and fix that part, but when it comes to that we have been successful with many students”

When it comes to the students who are not as gifted as the ones described above the interviewed teachers stressed how important it is to let also these students find out the questions by themselves and search for answers. In that way they will be able to develop skills as critical thinking and autonomy. During the first years of studying it is very much up to the student to ask questions and initiate interaction with as well other students as the teachers. Later on, in the project courses, these activities are built in already in the design

“On the CDIO-courses the students are allowed to initiate questions and actively search for knowledge. I am convinced that this approach supports their later ex-job”

“The students will probably gain a broader view on knowledge within the field through the CDIO-courses. There is not always one appropriate answer to a certain question”

One way to develop the skills of a scientist is to become acquainted with research work. This is something that the teachers in the study agree upon. However, they find it hard to integrate research into the teaching process at an early stage. One of them said like this

“On the basic courses in mathematics it happens that the students ask me: ‘How do you do research in mathematics?’ and that’s not easy to explain to them at that stage”

Later on it is easier

“I teach courses in the fourth year and I think it’s easy to relate teaching to research, especially in the CDIO-courses. There you can bring the very latest from research into the courses”

At the end of the focus group interview one of the teachers concluded:

“It is fascinating that we agree to a large extent when we discuss teaching like this. There is a culture and I don’t know to what extent you could say it is local. But, on the other hand, we spend our time here with colleagues who have also studied here, been fostered in the same culture and now act in the same way as *their* teachers once did”.

Alignment or dissonance between approaches to teaching and learning in relation to culture and program targets

Following the arguments of Alvesson [3] the results of these interviews indicate that the culture of the Y-program is enacted and strengthened through processes of normalization and subjectification, where students *and* academic staff create themselves as distinct kinds of subjects through self-perception and feedback from significant others. The “traditional design” of the program, meaning that the first two years should both lay a foundation of basic knowledge and skills and shape the students’ characters into disciplined, hard working and well performing students, is enacted in the design of the program as well as in the modes of

teaching and strategies for studying. Acting in this way, complying to the norms, is regarded as “normal”, although female students, as well as the only female teacher, comment on the different options there are for males and females to live up to, and perform, these standards [13] and Söndergaard [15] shows that women, in a male/masculine culture, have to perform their positions in a *different* way than their male peers. An example of this is that it is female students and the female teacher who argue that there is no discussions or reflections in the programme on the *meaning* of the studies and the *consequences* of the generated knowledge, which they lack. In the focus group interview the female teacher continuously asked her male colleagues about the meaning and relevance of their teaching, but the male teachers brought it back to the teaching of the courses. Another example is the female students who described the culture as very masculine and military like.

The teachers interviewed have themselves been “formed” as undergraduate students, PhD students and junior lecturer and they belong to those who have succeeded and made an academic career, not an engineering career, and the students comment that due to the tough and demanding studies they find themselves entangled in a “small world” of people of the same way of thinking, people who are prepared to work hard and make sacrifices in order to show that they are suited for the program. Those students who have doubts, or fail, or have ideas about other ways of running the program but stay, develop strategies where they gain more time and more personal control of their work situation. Ulrichsen [13] points out that the concept “the implied student” indicates that there is a structure, inherent in the way the study program is designed and carried through, but is it also a structure of action in the sense that students and teachers “do” the study in particular ways, in their actions.

Despite the fact that the reforms in the Y-program were aiming at attracting and keeping students, and there has been curricular reforms and a general change in attitudes, the underlying norms seem to persist, i.e. the basic structure and modes of teaching. Evidence for this is the alignment between the way the teachers talk about their teaching and the students’ learning in 2010 and the way the students talk about their learning and the teachers teaching between 2002-2007.

In this culture the first two years is also regarded as a period when students classify themselves and are classified by the program, based on the required standards for an Y-student. This kind of classification contributes to a sense of belongingness, of strengthening the bonds between those who are suited for this kind of studies and a justification of the design and the modes of teaching that these competent lecturers practice. The bond is further strengthened after the first two years, when the students are more free to elect courses out of interest and to take control over their work, and when the teachers meet with smaller groups of students who have elected their courses. At this point they meet in a kind of master-apprentice learning relationship.

There is an alignment between the approaches to teaching and learning and the program target about *knowledge and understanding*. There is also an alignment in the norms, how this is performed, through a fixed structure, cramming of content, reading for exams and a tight schedule the first two, basic years. Both teachers and student deliver intended results. For those students who are successful the reward is more committed teachers and better opportunities to choose courses out of interest and gain control of their work and for the teachers more committed students and a more professional relation.

There is some ambiguity in relation to the program target about skills and competence to work in teams and to collaborate in divers groups. As many students (but not all) and the teachers argue that this is on one hand what future employers require and it is fun and interesting to collaborate, construct and build and work in teams, but on the other hand this is time consuming, stealing time from “the real courses and the true teaching”. The learning of skills and competence is related to the project courses, and these are not defined as “real courses”, they are supplements to these.

There is little alignment in the approaches to teaching and learning and the program targets about skills and competence as critical thinking, solving complex problems and to show an ability to make professional judgements. The teachers argue that these skills and competences will emerge, as a result of graduating from the program, without teaching or examination, as these targets are difficult to assess. And the students argue that they learn these skills and competence in situations that are not related to “real courses” or “true teaching”. They learn this in project work, thesis work, work life experiences and social activities in the programme and in private life.

To conclude, the teachers argue that during the first two years of the programme they are not teachers, they are lecturers who deliver content in relation to pre set learning outcomes and a fixed structure. It is not until year three or four, when they supervise and lecture smaller groups of students, in their own field of research, that they *are teachers*. They “set eyes” on the students and get a more personalised relation to the students. The students have the same experiences. The culture of the program, the program design and the ways of teaching and practicing that are performed contribute to this successful story. But every success story also has a darker side, where those who have not managed, or wanted to adjust to the norms and rituals, have left the program, or suffered from failures and losing their self confidence and passion for the subjects. If this is desirable or a failure for the institution is a question of values. What is the sense of the programme and what kind of engineers do we want to graduate?

| DISCUSSION

The purpose of this paper was to highlight and discuss the impact of culture as a powerful outline for how to think, feel and act in a study programme in Engineering, the Y-programme, that has implemented a CDIO curriculum and since 1999 made curricular changes to meet the requirements of a CDIO syllabus. The results indicate that *despite* these changes made, both students and academic staff have the experience that there are powerful processes of normalisation operating, meaning that the basic design and structure of the program, as well as ways of thinking and practicing the subjects, are so taken for granted that changes within the program can only be done *within* these structures, the structures are not possible to change. This can be related to the proposals from “society” where the lack of interest among young people (read females) to study science and engineering is highlighted as a big problem. There is also a concern about the gap between the intentions and commitment of the academic world and the world of business, where the latter worry about graduates who do not hold enough “engineering competence”.

It is difficult, and challenging, to try to understand what this is all about. Our results indicate that the CDIO syllabus, especially project work, is considered to be useful and joyful experiences by students as well as teachers, and that it is in these settings that students reach several of the program targets. However these experiences are not considered to be “real courses” in the programme.

One way of understanding this is that these paradoxes are not only the results of what happens in this programme, it can be the result of the values in society. In Sweden there is now a debate about education and educational quality, enacted as a reaction to the last 20-30 years of educational reform, focussing student centred learning, group work and a study environment based on lust and joy. The reaction calls for “back to basics”, discipline, hard work and solid knowledge bases. The Y-program has maintained these values and virtues during these years, and thus been scorned and questioned for not adapting to the mainstream pedagogical strands. Has this been made possible because engineering is one of the last male/masculine dominated cultures in Higher Education? To change this culture, and welcome a diversity of students, and not only make supplemental changes that neither

teachers nor students incorporate as “real courses” or “true teaching”, might challenge the idea of what “quality” stands for. Is it desirable that the quality of an engineering education for the 21st century primarily is regarded a school for the forming of characters, like boarding schools and/or military services, or as a springboard for innovation, creativity, sustainability and the forming of democratic citizens who can communicate, negotiate and collaborate in a diverse, global society.

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