Is learning just about conceiving, designing, implementing and operating?

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In the 1st Annual CDIO conference in 2005, a paper was presented, about the expectations and first year experiences of four cohorts o students in the graduate engineering program in Applied Physics and Electrical Engineering, the Y-program, in Linköping Edvardsson Sstiwne, 2005). A comparison between the four cohorts showed a changing approach to studying between the first cohorts (starting in 1998 and 1999) and the latter (starting in 2000 and 2002). After the first year the students in the first cohorts were categorised as more "achievement and future oriented" compared to the students in the latter cohorts who were more "gratifying here- and now oriented". During the first year many students, for various reasons, dropped-out or decided to take a study break.

INTRODUCTION

The CDIO-curriculum can be described as a standard based, goal directed curriculum, developed in an international engineering context (www.cdio.org). A CDIO program is based on the principle that product and system lifecycle development and deployment are the appropriate context for engineering education. *Conceiving--Designing--Implementing--Operating* is a model of the entire product lifecycle. The *Conceive* stage includes defining customer needs; considering technology, enterprise strategy, and regulations; and, developing conceptual, technical, and business plans. The second stage, *Design*, focuses on creating the design, *i.e.*, the plans, drawings, and algorithms that describe what will be implemented. The *Implement* stage refers to the transformation of the design into the product, including manufacturing, coding, testing and validation. The final stage, *Operate*, uses the implemented product to deliver the intended value, including maintaining, evolving and retiring the system.
In 2004 12 CDIO Standards were adopted, seven of those are considered *essential* because they distinguish CDIO programs from other educational reform initiatives. In a CDIO program, the criteria of success are the 12 CDIO Standards. A program is considered effective if it can show evidence that the program components described in the Standards are in place. Different stakeholder groups will emphasize subsets of the 12 Standards, but all Standards are important measures for at least one stakeholder group. The CDIO concept is teacher centred from the point of view that it guides faculty how to *teach* in order to reach the goals.

The longitudinal study is made from a student centred, *learning* perspective. The entire study is based on self reported data on the students expectations, perceptions and conceptions of what teaching, learning and studying in the Y-program means. Program goals and intentions are interpreted and re-acted on by the students. The

base-line cohort in the longitudinal study were enrolled in 1998. The reason for the study board to initiate the study was to get a better understanding of why students dropped out during the first year and why students failed their exams. Another reason was to understand why the study climate, among students as well as faculty, was experienced as "grumpy" and tense. From 1999 the study board initiated changes in curriculum and in the study context, and the CDIO initiative was launched, in which students were invited to participate (Edvardsson Stiwne & Stiwne, 2000). The 2002 cohort was the first one where students were introduced to the Linkoping way of designing a CDIO curriculum from the very beginning. This is the reason why these two cohorts are focussed in this paper.

THE AIM OF THIS PAPER

The aim of this paper is to present some results from the interview study[1]. Drawing on biographical interviews with students in two of the cohorts, those who were enrolled in 1998 and in 2002, the focus is to discuss the students´ experiences *after* the first year in relation to changes made in the study context. The first cohort, 1998, studied in a traditional curriculum while the cohort of 2002 was the first to study within a CDIO-curriculum from the first semester. Ten students in each cohort have been interviewed once a year. The 1998 students have also been interviewed one year after graduation. When the latest interviews were made, in May 2005, the 1998 students had graduated and the 2002 students were finishing their third year. In this paper focus is on the students perceptions of their learning and teaching experiences during their entire study time.

The variation in perceptions are categorised for each cohort and the results are interpreted within a framework for understanding quality of learning and teaching, elaborated by Entwistle (2003) and the concept of situated conceptions of learning (Trigwell & Ashwin, 2006) and dissonance (Meyer, 1991; Lindblom-Ylänne, 2003; Prosser et.al, 2003; Vermunt & Verloop, 1999, 2000; Vermunt & Minnaert, 2003). The result of is discussed in relation to the CDIO concept.
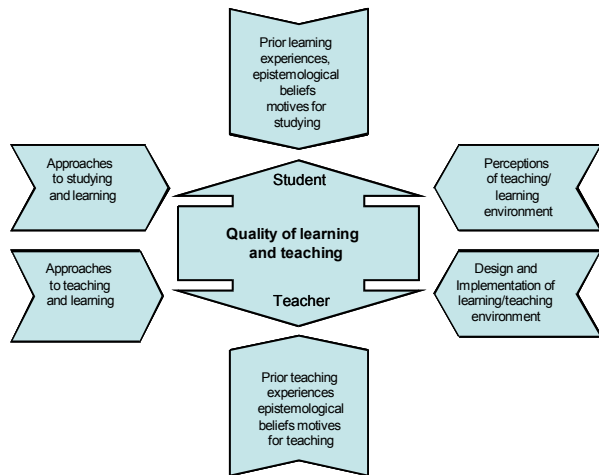
THEORETICAL FRAMEWORK AND CORE CONCEPTS

Quality of learning

ETL (Enhancing teaching-learning environments in undergraduate courses) is a conceptual framework constructed around a focal concept "Quality of learning achieved" (Entwistle, 2003). In that framework 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. These are referred to as WTPs (ways of thinking and practising in the subject). Within a specific subject area, i.e. engineering, crucial topics or concepts that affect how the teaching is carried out and how understanding develops, are identified. Troublesome knowledge (Perkins, 1999), threshold concepts (Meyer & Land, 2002) and delayed

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[1] This longitudinal study is based on data from four cohorts of engineering students enrolled in the program of Applied Physics and Electrical Engineering (the Y-program) at Linköping University in 1998, 1999, 2000 and 2002. Questionnaires have been distributed to all registered students and ten students in each cohort have been interviewed, on a regular basis throughout their whole study time with a follow-up one year after graduation (Edvardsson Stiwne, 2005). The project is funded by a grant from the Knut and Alice Wallenberg foundation

understanding (Scheja, 2002) are three emerging pedagogical concepts related to this model of student learning. When it comes to the way a subject is taught it is assumed that this is not due to a pure relation between teachers approaches to teaching and student learning (Prosser & Trigwell, 1999; Eley, 2002) as the nature of the subject taught and the organisational prerequisites clearly influences teaching methods and strategies (Entwistle, McCune & Walker, 2001). One conclusion from the ETL project is that the ways *teaching* is carried out on a course depend on the collective pedagogical WTPs of teachers providing it, but also by institutional priorities, the teaching ethos of the department and the strong outside pressures coming from the academic community and from validating bodies (Entwistle, 2003).

Figure 1: Quality of learning. The figure is elaborated from Entwistle, 2003

Situated conceptions of learning

Trigwell & Ashwin (2006) suggest that situated conception of learning, like prior experiences of learning, may be indicators of learning approaches and outcomes of learning. A situated conception is one that is evoked and adopted by students in response to their learning tasks in a particular context and may reflect the aims they have for their studies *once they have started that study* and experienced that particular study environment (see also Edvardsson Stiwne, 2005). Students whose situated conceptions are aligned with the aims of their higher education context, report adopting deep approaches to learning and perceive the learning environment more supportive than students with a non-aligned situated conception. The latter students´ aims with their studies are not consistent with the view expressed by the study context. Students´ perceptions of the learning context is based on their previous experiences of teaching and learning as well as of the course design in that context. The lowest quality and quantity of learning is associated with parallel adoption of both deep and surface approaches.

Teachers approaches to teaching and how they perceive their teaching context is a function of their previous experiences of teaching and the way their department structures the teaching context (Prosser & Trigwell, 1999). Teachers adopting student-focused approaches to teaching perceive that they have control over their teaching, that class is not too large and that their workload is not too high and that their department values teaching. A conclusion from one of their studies is that a vast majority of science and engineering subjects were in the Lower Quality learning cluster, indicating that there may be more *dissonance* in the teaching of these subjects. When teachers hold the belief that conceptual change and development occurs through the accumulation of more and more information, and students hold the belief that this occurs through the elaboration of knowledge I relation to their own experiences the learning situations is characterised by dissonance.

Dissonance, friction and study orchestration

Dissonant study orchestration (Lindblom-Ylänne & Lonka, 2000; Lindblom-Ylänne, 2003) reflect students problems in adapting to their study environment and this incongruency, or friction (Vermunt & Verloop, 1999) can be constructive and challenge students or destructive and inhibit students learning or contribute to their withdrawal. Meyer (1991) drew attention to dissonance in students´ learning patterns, i.e. when the expected and theoretically coherent linkages between learning conceptions, intentions, motives and processes fail to appear in empirical studies.

Using the concept of "study orchestration", defined as a contextualised study approach adopted by individual students or groups of students, three aspects of student learning are recognised: the existence of qualitative, individual differences in students approaches and engagement in learning tasks; the influence of context on the engagement; a variety of conceptions of learning among the students. A conclusion from the study is that what people do to learn converges with their views about, and motives for, learning. One example is when students come from a teacher centred study context in secondary education to a student-oriented context in the University (or vice versa) they might experience a period of friction between their previous learning conceptions, orientations and strategies and those being introduced in the new context (Vermunt & Verloop, 1999).
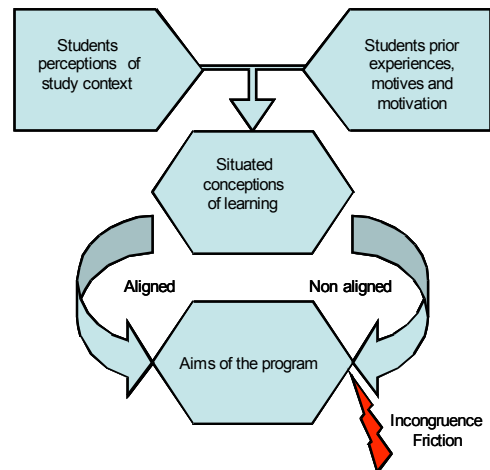
Figure 2: Aligned and non aligned situated conceptions of learning

THE CONTEXT

In this paper the concept of "context" is used in a broad sense, as a nationa/international educational context, as the local study context of the Y-program and as the life context of an individual student being interviewed at specific moments during the study time. I will give a brief overview of the national and local context, as one assumption in the study is that the outcome of curricular changes must be related to a wider context than the intentions of faculty and the motivation and capacity of individual students.

The national context

In Sweden, theoretically, all students have the opportunity to enrol into a Higher Education program, as there are no student fees and all students can have student grants and loans. In 2004 the enrolment rate was about 43% (HSV årsredovisning 2004). 70% of the children from upper-middleclass background enrol in comparison to 23% from working class background. This uneven recruitment is most evident in medical- law- and engineering education.

In order to meet the demands of a well educated work force in Europe, Ministers from 29 European countries in June 1999 signed the Bologna declaration with the joint objectives of developing a coherent and cohesive European Higher Education Area (EHEA) by 2010. The main issues for the participating countries are to promote
• the development of a two-cycle system with a basic and an advanced level

- student- and teacher mobility, nationally and internationally
- international curriculum development
- the development of a European Qualifications framework
- a European dimension of Higher Education where a social dimension is emphasised

Every six year the National Agency for Higher Education (HSV) evaluate all study programs and in 2005 the Graduate Engineering programs were evaluated (HSV 2006:8), The general statement was that the programs are good but that the Graduate programs should be five instead of 4 ½ years; that the management of the programs should improve and that the pedagogy and study cultures must be reformed, especially as the enrolment rates are steadily decreasing, in spite of recruitment efforts at al levels, and the throughput is low. The 2005 evaluation was to some extent based on the CDIO standards.

The University and the Y-program
Linkoping University is one of the five largest Universities in Sweden with three faculties located in three campuses. Multi- and cross-disciplinary work as well as a student-centred pedagogy characterises the University as a whole, but the three faculties have different profiles. PBL (problembased learning) is a profile in the faculty of Medicine and group- and projectbased learning is emphasised in the faculty of Philosphy, while traditional scheduled lectures and laborations still are most prevalent in the faculty of Technology, although the CDIO curriculum is gaining more and more influence.

The Y-program is a 4½ year graduate study program. It is considered to be one of the t   oughest and most demanding graduate programs in Engineering. The students have a reputation of being ambitious and clever, but also a bit square and dull, (Edvardsson Stiwne et.al 2002). The program is managed by a study board within the Deans office. The board has an elected chair and the members are
*Teachers from the departments running the specific classes
*Students from different cohorts
*Administrators from the Deans office.
A study program does not "belong" to a department but "buys" courses from different departments. Every August about 180 students are admitted. They are enrolled into 5-7 classes with about 30 students. Female students are in minority, between 13% and 18%, and they are allocated to some of the classes, which means that there always are some all-.male classes. Senior students are appointed as form masters/mistresses, teacher assistants, mentors etc. for first year students.

The curriculum the first year consists of a foundation course in mathematics, linear algebra and perspectives on mathematics and physics. The work is organised in lectures (the whole cohort); classes (lessons with one class); laboratory lessons (the students work in pairs or small groups) and projects (small groups). Lectures are given by professors, who also tutor and supervise projects. Teaching assistants are supervising in classes and laboratory lessons. Course evaluations are made on the internet and the results are communicated to the chair of the study board, where the evaluations are followed up and attended to. Each course is evaluated according to a scoring system. An examiner can get an honourable mention or a request to make some improvements.

In 1999 the CDIO-project was initiated. This was rendered possible with a financial support by the Knut and Alice Wallenberg foundation. In order to meet the critique from the 1998 cohort of a tough start in mathematics, a foundation course in mathematics was launched this study year.

In 2000 a new class was launched, Yi (Y international). The students were offered classes in a foreign language and to spend one semester in a foreign country. These students were not supposed to participate in the CDIO project course during the first semester. The implementation of the CDIO curriculum started in 2000, with structured interviews with all teachers involved in the Y-program in 2000/2001. The purpose of the interviews was to make the teachers familiar with the core concepts in the project, Conceive, Design, Implement and Operate. Another intervention in line with the CDIO-curriculum was that all new students filled in a "Beginners survey". The results were followed-up by the study counsellors. They identified what the main obstacles and problems were, and offered individual counselling to the students. From 2002 there is an engineering project (a CDIO-class) the first semester

During the study year of 2001/2002 the implementation of the CDIO curriculum continued. The student reception was improved and the first CDIO project course was planned. Potential project managers were taught a project model, LIPS, and there was a request to different departments for interesting projects. The "Beginners survey" was launched to all students in the Faculty of Technology, in order to make it possible to compare the different study programmes.

In the study year of 2002/2003 the first CDIO-project course was implemented during the first semester. Besides the follow up of the "Beginners survey" the study counsellors launched the idea of "Student mentors". The aim was to facilitate the students´ adjustment to university studies with the help of a counselling method "Supplemental instructions".

The implementation of the CDIO curriculum has continued from 2002, with CDIO-project courses in year three and four. From the description above it is concluded that due to planned curricular changes, the study contexts of the students are changing. This will be considered in the interpretation of the data.

RESULTS

From the start there were ten students interviewed in each cohort, five men and five women. Due to study leaves and other circumstances all students have not been interviewed every year. The results are based on interviews with "successful student", i.e. those who have remained in the program after the first year. This should be considered in the interpretation of the data. Citations are used to give a typical example of sayings in a particular category. The main categories, "Previous experiences"; "Approaches to learning and studying" and "Perceptions of the study environment", are deduced from the theoretical framework,. The results are focussed on the *variation between the cohorts* are discussed in relation to the theoretical framework. This means that the similarities within and between cohorts and variation between individuals within the cohorts will not be elucidated.

The 1998 students
The 1998 sayings about their previous experiences were grounded in *personal* experiences of social opportunities, education and work life.
Previous experiences
Failure in secondary school and a new motivation in work life or adult education.

> In secondary school I had no ambitions, it has come now, later on.. In secondary school I was very tired of school and I was not doing very well…I enrolled I a class in Adult education and discovered that I had a talent for mathematics and that I quite enjoyed studying.

Being successful in secondary school. The result was that they came to the University with the experience of being among the best in class, with and without too much effort.

> …being very successful in secondary school and then doubt yourself is very heavy but you do not want to give up, I wanted really to try before I gave it up...it would have felt like a defeat

Work life and employability.

> I had been working (in industry) before I started…The reason for taking up studying was that I had been made redundant.

Expectations

From their variety of previous experiences they expected that a prestigious and challenging education would be one path to *a good future, life and career*

> ..when we started in 1998, everything sounded fine, the times were bright. We expected to have the opportunity to choose among jobs. At that time nobody could imagine what it would be like.

Most of the students expected a tough start in a tough program and had a variety of motives for choosing the program and of strategies to meet the challenges.

Motives for studying

To meet expectations from "society"

> but it is so nowadays that everybody is expected to go into secondary education and that´s not good.

You must do something

> ..I did not work very hard in secondary school..I had heard that this program was very tough, so my ambition was just to pass. Honestly, I did not really know what I would become when I started. I just wanted to do something, and most of all a graduate engineering program.

An urge for a challenge – to test ones limits

> ..I started to test if I could make it or not. I did not know if I should make it or if it would be too difficult.. I look for challenges,, in the winter I go skiing, living in a tent and that I find a bit challenging.

Pure interest in a subject without thinking about employability

> ..when I chose this program I just thought this looks good and suits my interest..

There is a great variety in their motives for studying but a pattern is that they have *personal experiences* that guided their choices *of* something they believed would mean a better or different future. For some students this is related to *a future way of living*, for others to *personal development*. An underlying epistemological belief is that learning is a process of change that requires some effort from the student, but also that if you put that effort in there will be some kind of reward in the future. Due to their previous experiences of work life their motives are aligned to what "society" expects from them, to graduate in order to get a job that is not associated with manual, routine jobs. Some of them also had their own experiences of being made redundant. According to Entwistle (ibid.) the students´ previous experiences, expectations and motives for studying will influence their approaches to learning and studying and their perceptions of their study environment. As Trigwell & Ashwin (2006) argue, a crucial question for student satisfaction, achievement and retention will be the degree of alignment between the students´ motives and goals and the motives, goals and intentions of the program, i.e. their perceptions of the study environment.

Reflections on their teaching/learning environment.

The 1998 students were a big group, 185 students, divided into 6 classes of about 30 students. They expected a tough start with lots of scheduled work and an emphasis on mathematics. There were no organised work groups or project groups, but many students created small study groups, more and less formal and social. The study counsellors encouraged the students to study together, to discuss and exchange experiences, instead of just studying on their own. One recurring experience is that they have learned to "cram in" anything, but also that they can ask people and get help and support. The examinations trigger the students´ interpretations of what the goals of faculty are. It is to get the students to adjust to the forms of examinations (old examinations for sale in the book shops) and to get a good financial result.

> ..I think we would learn more if we did not have the possibility to read old examinations…I think you would focus more on the courses as a whole.. as a student you get used to it from the start and faculty wants to have students passing so they get their money…it been some rumours about that, not just here but at the university as a whole, that they make easier examinations in order to have more students pass, as that is the base for financing the university.

They believe that the first tough start is intentional, to sort out the "deficient" students, and some students also comply with this, as they believe the quality will deteriorate otherwise.

> …frankly I do not think it is wrong to have a tough start so you know what it is all about…everybody know that the Y-program is tough so maybe it is better to keep It tough from the start… maybe better to drop out year one than in year three with 2 ½ year of study

The hurried pace is interpreted as one way to sort people out.

> .. I suspect the aim is that we shall learn to work under pressure, at a hurried pace….the pace is hurried, you are expected to learn quickly.. but my feeling is that it has been a turning point at the end of the third year when we have had the opportunity to choose our courses it is as if it has been a change for the better.

After the tough start they describe a change in attitudes (these are the students that have managed to stay on) and they believe the intention are that they shall learn to be more and more autonomous learners which also influences their own motivation.

> …the work is more self-governed than before, this has come gradually but I have noticed that they put heavier demands on you and this makes it more fun
> ...from the start the aim of the laboratory work was that you should follow an instruction, but now they give you a task and leave it up to you to carry it through without help or instructions..
> …we now have a project (in year 4) and as always with that kind of work it is more time consuming that you anticipate, but you learn more than in more traditional work.

The students´ perception of the teaching/learning environment is that applicability and their future employability is not high up on the agenda, and this becomes more and more of a problem for the 1998 students the closer they came to graduation.

> ..within the program we have not prepared ourselves for entering into the labour market

But it was not just the intentions of faculty, also the intentions of other students were creating some tensions in their approaches to study.

> …at the beginning there was a lot of parties and stuff that took a lot of time and energy… but then, it came to a point when… now, this has to stop, I am here to study and that has to be the most important

According to Trigwell & Ashwin (2006), a situated conception of learning is evoked and adopted by students in response to their learning tasks in a particular context and may reflect the aims they have for their studies once they have started studying and experienced that particular study environment. If their conceptions are not aligned to the aims of the program, the assumption is that there will be a friction, an incongruence, that can be constructive or destructive for their retention and learning(Meyer, 1991; Vermunt & Verloop, 1999; Lindblom-Ylänne, 2003).

Situated conceptions of learning: 1998 students.
For most of the students there was a period of *adjustment* to the study context. For some of them "learning" was very much about "getting the hang of it", to "crack the educational code" the first two years.

> I studied much harder year one than year two, because you learn how to absorb things.. the start was horrible, I could not believe it was true! I studied terribly hard to get the hang of it all, but I think my study technique was bad also.

To "crack the code" was understood as the interpreting and understanding of the design of curriculum and the teachers approaches to teaching and learning and thereby the teachers epistemological beliefs. The "code" was that learning was the ability to cram in, to "absorb knowledge". In order to manage that you had to learn how to study. As learning for many students is very much associated with achievement one problem was that students thought they did not learn if they did not recognise any obvious and visible results. That can be one explication of why *applicability* is so highly valued. For these students "calculation" is perceived as hands-on and contributes to a sense of pride and satisfaction when you have done your assignments compared to "just reading and thinking". This way of thinking gives meaning to the activity of calculation, of sitting and working on you own.

The students who had "cracked the code" and adjusted to the context, they experienced a turning point during the *third* year. Although the 1998 students were not involved in a CDIO curriculum, they made choices of their own interest for their profiles in year three and they did have a project course in year four,

> …it is now, year three, you realize that what you studied in year one and two is built upon.. In year one and two I perceived it just like stuff taken out of context

Learning as achievement gets another meaning from that point. Learning now was associated with an ability to *integrate previous knowledge* into new situations, to comprehend more complex problems and to work more independently all are associated with learning.

> ..what I have learned…a lot of technically, high quality stuff… but also to comprehend very complex, what appears as complex to other people but which I might not consider so complex…you can read a complex text in English and quite early understand.. without worrying about that you do not comprehend immediately, you can take it in, memorise it or take a note and then comprehend it later, without being upset because you do not comprehend it immediately…you get used to realising that you cant get it at once.

This student verbalises the concept of *delayed understanding* (Scheja, 2002) to understand learning as something that "comes to you" a while after a specific learning situation. By the end of their education they summarise their learning experiences in saying that maybe it is not the theoretical knowledge that has been

most important, but the ability to think analytically and to approach problems in different ways and to solve problems. Learning is therefore not only the content, *what* they have learned, but very much about the form, *how* they have learned. From their "traditional" curriculum they perceive that they have learned self-regulation, to balance individual and group work; to estimate time and effort in relation to specific tasks; to balance pleasure and necessity; to make ethical considerations in relation to achievement. They also have learned something about their own learning related to their personal motivation and driving forces, i.e. their self image and self efficacy.

These students´ previous experiences are of external factors influencing their motives for studying and choice of program, but also the "discovery" of some kind of internal, previously hidden capacities as well as urges to challenge themselves and test their intellectual and personal capacities. Seeing oneself as a "meaning seeker", a "gifted and intelligent person", a "born success", or an "endurer" will influence their actions, their way of learning, studying and relating to the study context. The question is if these categories are to be regarded as fixed entities, personal characteristics, or socially constructed in a context.

The 2002 students
The 2002 sayings about their previous experiences were grounded in *personal* experiences of education and of being a student, but more mediated experiences and anticipations about work life and a future career.

Previous experiences
Among the 2002 students the perception of *learning as something that comes natural to some people* is prevalent, as it is some innate capacities and urges that the students can control themselves. The social environment is attributed a great importance in *if* and *how* these capacities are the manifested and developed. Learning is a personal capacity mediated by a study context. Learning, as a cognitive process is facilitated or inhibited by the presence of other people, by the social context.
Competition and focus on achievement in secondary school were experienced by many of the interviewed students, focus was on grades and only the highest grades mattered.
> ..in secondary school everybody were pushing themselves to get the best grades..we had two tests a week and you had to study all week ends…I had extra curriculum as well

The students´ previous learning and educational experiences is *that "schooling" can ruin a genuine interest in something*. They make a difference between keeping and developing an interest in something and studying what they consider to be useful for their future employability. This is reinforced by their experience of a highly competitive learning context with a focus on achievement and grades.

A rather narrow, homogeneous personal and social context was maintained in the program as most students had few social relations in Linkoping outside their class or program.
> all my friends study at the University… I only see people with those interests.

Expectations
Uncertainty about the future is expressed by the students´ in this cohort, their expectations about their educations as well as of their future careers are vague and

ambivalent. They focus on living here-and-now and keeping all doors open as long as possible

> …the present is more salient than the future…I utterly seldom think of what I do in relation to future actions.
>
> ..the future seems very blurry for many..few in my class had a clear aim about the future..I can´t think of anyone who has ideas of what they want to do in the future.. it is very much here-and now, the next examination.
>
> ..I do not know what to do in the future.. a variety of options so you can make choices later on.

They expect to spend long days at school and they expected a tough start, but they also were open to change program if it did not "feel right".

Motives for studying

As their expectations were vague their motives for studying were vague as well. The motives were articulated more as optional exclusions than options

> …and I did not want to work in a super market or something like that for one year (so I came directly from secondary school).
>
> … with this education I anticipate to have many options, I will not have to work in a hospital, maybe to be a researcher is my primary aim.
>
> the wide approach…as a matter of fact I did not think so much about the reasons as my original plan was to become a pastor.
>
> ..the prime mover is that I want to show that I can make it...I am a bit competitive… but not at the price of my life
>
> …my driving force is my interest in subjects… to learn to develop, invent and build something.

These students do not say that post secondary schooling is an option for future work, but an implicit assumption is that continuing "school" is taken for granted without explicit goals for the future. "University" is imagined both as a prolonging of secondary schooling and as an intellectual and vocational specialisation. The students do not know what they want to do but what they do not want to do in the future. In making optional exclusion of subjects, study contexts and relations they create a personal life-space where they can be safe for a couple of years before and where they can keep "the realities of life" at a distance. With reference to the theoretical framework this could be a challenge for the study context, if the aims and goals of the students are dissonant with the goals of the program. The CDIO curriculum is a standard based and goal directed curriculum while the students´ aims seem rather vague and diverse. One indicator of if their aims are aligned to these clear program goals or not is their reflections on how they have perceived the study context and interpreted the intentions of the program.

Reflections on their teaching/learning environment.

The 2002 students reflections on their teaching/learning environment were focussed on how gratifying the studies were for *them*, on their options to find " a decent life", a balance between studies and free time, and on how the study context energised and challenged them.

> …most students study because it is fun…few think about it as potentially job related…but 90% of us will of course have to do that later on.
>
> …I would not mind having better grades but I have not studied too hard, if I had put in more effort I could have done better but now I have time to do other things as well.. I take it easy and then you do not get fed up so easily.

Their experiences of competition from secondary school has very much influenced their perceptions and experiences.

> …The others believe that the highest grades are what counts… I believe myself that it is a bit weird with people who score fives all over .
>
> … if it is easy and you sit in a group you might have to spend time to help somebody else… then you might want to get a good grade and put your effort on your own work.. a bit ego but maybe natural.

This also influences their relation to peers and to group work, as this is organised in the CDIO projects for the first time. Their epistemological belief, that they have a natural aptitude for studies, but the study context influence if this aptitude is encouraged or inhibited, also indicates that study groups (that they are assigned to an not chosen themselves) as well as lecturers are seen as tools in their individual study project. Failures and successes are attributed to contextual circumstances.

> ...if there is an easy course I study on my own, but if it is more difficult I seek the company of a group.
>
> ..I have passed two examinations now, one was a blocked course for year three, I have struggled with that one, it was not so difficult but I had some bad luck.. on the other hand I were lucky and passed examinations I really did not put enough effort in.. at one period I had three examinations in one week so I only had one day to study for one of them, I took a chance.

When they reflect on their perceptions of the study context they focus very much on the examinations, in spite of the fact that they say that they study of interest, do not ogle about the future and that were fed up with the competition from secondary school.

> … if I only had known more about what the examination was like and I devoted to little time studying previous examinations.. but it is some routine you get after a while, you know how to study for the examination, it is a particular thing to study for an exam
>
> .. I have changed my study strategy.. from hard study before examinations to study more continuously, I know that this is the strategy that works for me if I shall pass
>
> …Year two was rather boring...sometimes it is very boring when you have a lot of examinations you never ever have time to comprehend, but other times you get it all right, you understand and it is super!
>
> …there is never enough time to learn everything but obviously I have managed to get enough knowledge to pass the

Situated conceptions of learning: 2002 students.

Learning is *a personal capacity mediated by a study context.* Learning, as a cognitive process is facilitated or inhibited by the presence of other people, by the social context.

> …I need time to do the sums myself, to think and reflect before I can talk to other people… after that I might discuss formal matters with other people but I don not want to have my way of thinking disturbed by someone else coming up with something really smart when I am half way into something..

Learning is very much *associated with joy and fun*, with interest in a subject and with challenge, with something that makes you feel alert and energised.

> ...if I am interested in something I put a lot of effort in… If it feels meaningful to me I enjoy working and studying it
>
> …Year two was rather boring...sometimes it is very boring when you have a lot of examinations you never ever have time to comprehend, but other times you get it all right, you understand and it is super!
>
> …We read stuff I enjoy.. I now that I have no problem with studying and I suspect it is going to be quite interesting to work as an engineer...I get on very well

Learning as *a search for meaning*, of intellectual stimulation and/or skills that will be useful for society or for a future career was voiced in relation to a feeling that they sometimes had lost trace of their aims. Instead they focussed on understanding the aims of the program and to their adjustment to that.

> ..we had one bad class...they tried to cram in too much stuff, the pace was too rapid and they did not go deep enough into it…we had some good classes where you could understand directly and where they got a bit deeper into the subject

Learning is described as a friction between the students´ own perception of learning as understanding and the examinations focus on memorising and cramming. Learning becomes synonymous with "adjusting" and "managing the assignments"

One way of managing this friction is to perceive *cramming as an initial necessary stage in learning for later (delayed) understanding*.

> …at the beginning, whey you should learn all weird things, so many things you never ever heard about before…but now you realise that these are indispensable if you shall manage the class in physics I am in now...it is not until now I realise that I am applying all that maths we had for the first years.

Even though learning is *associated with achievement and to be able to apply theoretical knowledge in real situations*, all students did not perceive the first project course that way, instead it was perceived a nice break in "the real stuff".

> ..the project course (in year one) was a non-committed course, it was nice to have a break among all boring subjects.
>
> (from the project course in year three) I enjoyed...we had a specification of requirements but after that we were free to do as we pleased...and the satisfaction in feeling "we made it".. knowing that we can apply what we have learned… and we have learned to co-operate and to structure our working time etc.

CONCLUSIONS

The variation between the cohorts that we recognised after the first year seem to persist. In spite of the intra group variety within both groups of student, the previous experiences and anticipations for the future between the groups remain diverse, and as Entwistle (2003) argue, this must be considered in the evaluation of the quality of learning. Learning seem to be something else than conceiving, designing, implementing and operating some preset standards if these are not aligned with the students previous learning experiences, expectations and motives for studying.

In both groups the students have chosen the Y-program because of its´ good reputation as a broad, high quality and tough education. The meaning of that becomes different, due to the students´ previous experiences, expectations and motives for studying. The 1998 students previous experiences were more diverse and based on personal experiences of education and work life, compared to the 2002 students who had more homogeneous and limited personal experiences. The expectations of the 1998 students focussed on the work they would have to do to manage the program in order to get a good future life and career. This guided them to their choices *to* actions they believed would be good for their future. The expectations of the 2002 students were focussed on their life as students and the expectations for the future were blurry and vague. This guided them in their choices *from* actions they anticipated would limit their options for the future.

The 1998 students entered into Higher Education, in a national context where the belief that education is the prime mover for economic and social growth is prevalent.

A goal in Sweden, as within OECD, is that 50% should go into tertiary education before the age of 25; the creation of a European Higher Education Area has began with the "Bologna process; the IT-sector is at its´peak. The attrition rates for the Y-program was quite good and the program was marketed as the best and toughest graduate program, a challenge for the student. The students enrolled in a program with a quite "traditional" engineering curriculum, big classes, lots of maths at the beginning and tough examinations. When the 2002 students were enrolled the IT-sector had collapsed and lots of i.e. engineers had been made redundant. Sick leave rates had risen in all sectors and a discourse about stress and health was prevalent in media as well as in work life. Studying was the prescription for a ticket into a highly competitive labour market. The attrition rates were declining within the faculties of Science as a whole, but the Y-program was still quite competitive. The students were enrolled in a study program that during a couple of years had been working very hard to develop a CDIO curriculum, and this was to be implemented for the first time in the class of 2002.

Trigwell & Ashwin (2006) argue that a situated conception of learning is evoked and adopted by students in response to their learning tasks in a particular context. Previous results in this longitudinal study show that it is not until the students start their studies that they become aware of their aims, motives and goals (Edvardsson Stiwne, 2005). The situated conceptions of the 1998 students are that the intentions of faculty is to test the students´ capacity from the start and those who "survive" have then proven to be worthy to concentrate on. The "reward" is that after the third year they are encouraged to be more autonomous and to let their own interests direct their choices of classes and subjects. Even though some of them experience some friction (Meyer, 1991; Vermunt & Verloop, 2003) between their own approaches to learning and studying and those of faculty, their over all aims were aligned with those of faculty. Tough demands and hard work is necessary in order to keep up the reputation of the program and the students did not want to see their profession being reduced. The students were prepared to adjust to and adopt the standards of the program. The situated conceptions of the 2002 students are that learning is a personal capacity, mediated by a context. Learning should be associated with energy, joy and lust in order to be motivating and encouraging them to mobilise their capacities and put in necessary efforts. Their anticipations of a future career is blurry and vague and therefore content and forms of the curriculum was evaluated in relation to their visions about their future, or to their everyday achievements and relations. These students had previous experiences of a secondary school where focus was on grades and high achievement and therefore they emphasised the belief that a balance between "life" and work (studies) was necessary, but at the same time they "used" curriculum and peers as tools in their ambition to design their personal learning context. This personal and individualised way of thinking about their studies and future career was dissonant to the goal directed and standard based CDIO curriculum and the friction they experienced was very much about a feeling that their "natural aptitudes" for learning and studying were not really taken care of in the study context. Their aims with their studies, to learn from pure interest in a context where they get energised, encouraged and challenged, is not aligned with the goals and standards of the CDIO. This is i.e. enacted in their way of interpreting the goals, of trying to fit these goals into their own agendas and resist being directed into a way of acting and behaving that they themselves cannot control.

In focussing on the variation between the cohorts we loose track of individual differences within the cohorts and on the similarities between the cohorts. The interviewed students have all managed and persisted in their efforts to graduate, although in different pace and with different feelings and strategies. By the end of their education most of them are satisfied and on their reflection on their study time they summarize their learning experiences as learning to regulate their own learning, to balance individual and group work, to think analytically and approach problems in different ways. They have also learned something about their own learning related to their personal motivation and driving forces, but they doubt the value of all this in relation to the demands of future employers.

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