

# Situated conceptions of learning and the reforming of an engineering programme

Elinor Edvardsson Stiwne

Linköping University  
Linköping, Sweden

**ABSTRACT:** In this article, the author presents the results from an interview study. Drawing on biographical interviews with students in two of the four studied cohorts (ie those who were enrolled in 1998 and in 2002), students' experiences of learning and teaching after the first year are discussed in relation to changes made in the study context. The first cohort in 1998 studied in a traditional curriculum, while the cohort of 2002 was the first to study within a *Conceive – Design – Implement – Operate* (CDIO) curriculum from the first semester. Ten students in each cohort were interviewed once a year. One conclusion presented in this article is that the alignment between students' aims and goals, as well as those of faculty, are crucial for the situated conceptions of learning. The CDIO Standards were implemented from 1999 onwards, but during the same time, students aims and goals were changing, as well as the national and international demands on higher education and the labour market. The results from this study are unique, as it is a longitudinal case study undertaken in one specific programme, showing the difficulties of evaluating the specific effects of CDIO interventions.

## INTRODUCTION

In this article, the author presents the results of a longitudinal study based on data gathered from four cohorts of engineering students enrolled in the programme of *Applied Physics and Electrical Engineering* (the Y-programme) at Linköping University, Linköping, Sweden, in 1998, 1999, 2000 and 2002. Questionnaires were distributed to all registered students and 10 students in each cohort were also interviewed on a regular basis throughout their whole study time, with a follow-up interview one year after their graduation [1].

Drawing on biographical interviews with students from two student cohorts (specifically those enrolled in 1998 and 2002), students' experiences of teaching and learning are discussed in relation to the implementation of *Conceive – Design – Implement – Operate* (CDIO) Standards 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 very start. Ten students in each cohort were interviewed on a yearly basis. The 1998 students have also been interviewed one year after their graduation. When the latest interviews were conducted in May 2005, the 1998 students had graduated and the 2002 students were finishing their third year. The variation of experiences between cohorts is focused on in this article and the results are interpreted within a framework for understanding the quality of learning and teaching, as elaborated by Entwistle and the concepts of situated conceptions of learning and dissonance [2-9].

## THEORETICAL FRAMEWORK AND CORE CONCEPTS

### Quality of Learning

Enhancing teaching-learning environments in undergraduate courses (ETL) is a conceptual framework constructed around the focal concept of the *quality of learning achieved* [2]. The

concept of *student learning* is broadened from a focus on conceptual understanding to covering additional skills and ways of thinking, both academic and professional, referred to as ways of thinking and practising in the subject (WTPs).

Within a specific subject area, ie engineering, crucial topics or concepts are identified that affect how the teaching is carried out and how understanding develops. Three emerging pedagogical concepts related to this conceptual framework are as follows:

- Troublesome knowledge [10];
- Threshold concepts [11];
- Delayed understanding [12].

It is assumed that the manner in which a subject is taught is not merely due to the relation between teachers' approaches to teaching and student learning [13][14]. It is also a result of the nature of the subject taught and organisational prerequisites, as these are assumed to influence teaching methods and strategies [15]. One conclusion from the ETL project is that the manner in which *teaching* is carried out on a course depends upon the collective pedagogical WTPs of the teachers providing it, as well as by institutional priorities, the teaching ethos of the department and the strong external pressures coming from the academic community and validating bodies [2].

### Situated Conceptions of Learning

Trigwell and Ashwin argue that the situated conception of learning, like prior experiences of learning, may be indicators of learning approaches and the outcomes of learning [3]. 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 that they have for their studies *once they have started that study* and experienced that particular study environment (see also ref. [1]).

Students whose situated conceptions are aligned with the aims of their higher education context report adopting deeper approaches to learning and to perceiving the learning environment as being more supportive than students who hold a non-aligned situated conception. The latter students' aims concerning their studies are not consistent with their intentions in the study context. Students' perceptions of the learning context is based upon 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 a parallel adoption of both in depth and surface approaches. Teachers' approaches to teaching and perceptions of their teaching context is a function of their previous experiences of teaching and the way their department structures the teaching context [13].

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 the learning situations, then this situation is characterised by dissonance.

#### Dissonance, Friction and Study Orchestration

Dissonant study orchestration is one way of understanding students problems in adapting to their study environment [5][16]. This incongruity or friction can be constructive and challenge students, or it can be destructive and inhibit students learning, even contributing to their withdrawal [7]. Meyer drew attention to dissonance in students' learning patterns, ie when the expected and theoretically coherent linkages between learning conceptions, intentions, motives and processes failed to appear in empirical studies [4].

Using the concept of *study orchestration*, which is defined as a contextualised study approach adopted by individual students or groups of students, three aspects of student learning were recognised, namely:

- 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 by students.

A conclusion from the study is that students' study strategies converge with their views about, and their motives for, learning.

#### THE CONTEXT

In this article, the concept of *context* is used in a broad sense as a national/international educational context, but also as the local study context of the Y-programme and the life context of the individual student being interviewed at specific moments during his/her study time. One assumption in the study is that the evaluation of curricular changes must be related to a wider context than the aims and intentions of faculty, as well as the motivation and capacity of individual students.

#### The National Context

In Sweden, all students have the opportunity to study at the university level, as there are no student fees and all students

have access to student grants and loans. In 2004, the enrolment rate was about 43% [17]. Approximately 70% of children from upper-middle class backgrounds enrol at university, compared to 23% from working class backgrounds.

In order to meet the demands of a well-educated workforce in Europe, Ministers from 29 European countries signed the Bologna Declaration in June 1999 with the joint objectives of developing a coherent and cohesive European Higher Education Area (EHEA) by 2010.

Every six years, the Swedish National Agency for Higher Education (HSV) evaluates all study programmes and, in 2005, graduate engineering programmes were evaluated [17]. The general statement was that the programmes are good but that graduate programmes should be five years in duration (instead of 4½ years), the management of the programmes should improve, and that the pedagogy and study cultures must be reformed, especially as enrolment rates are steadily decreasing, despite recruitment efforts at all levels and given that the throughput is low. The 2005 evaluation was, to some extent, based on the CDIO Standards.

#### The University and the Y-Programme

Linköping University is one of the five largest universities in Sweden. Multi-disciplinary and cross-disciplinary work, as well as a student-centred pedagogy, characterises the University as a whole, but the three faculties have different profiles. Problem-Based Learning (PBL) is a profile in the Faculty of Medicine, while group and project-based learning is emphasised in the Faculty of Philosophy. Traditional scheduled lectures and laboratory work still are most prevalent in the Faculty of Technology, although the CDIO curriculum is gaining more and more influence.

The Y-programme is a 4½ year graduate study programme. It is considered to be one of the toughest and most demanding graduate programmes in engineering. The programme is managed by a programme board within the Dean's office. Every August, about 180 students are admitted. They are enrolled in five to seven classes with about 30 students each. Female students are in a minority, ranging between 13% and 18% of intake composition, and they are allocated to some of the classes, which means that there are always some all male classes. Senior students are appointed as a form of masters/mistresses, teacher assistants, mentors, etc, for first year students.

The curriculum in the first year consists of a foundation course in mathematics, linear algebra and perspectives on mathematics and physics. The work is organised as follows:

- Lectures (the whole cohort);
- Classes (lessons with one class);
- Laboratory work (students work in pairs or small groups);
- Projects (small groups).

Lectures are given by professors, who also tutor and supervise projects. Teaching assistants help to supervise classes and laboratory lessons. Course evaluations are carried out over the Internet and the results 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 receive an honourable mention or a request to make some improvements.

The CDIO project was initiated in 1999. This was rendered possible with financial support from 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 in this study year. In 2000, a new class was launched, Yi (Y international). Students were offered classes in a foreign language and to spend one semester in a foreign country. These students had not participated 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-programme in 2000/2001. The purpose of the interviews was to make the teachers familiar with the CDIO core concepts of *conceive, design, implement and operate*. Another intervention in line with the CDIO curriculum was that all new students filled in a *beginner's survey*. The results were followed up by study counsellors. The implementation of the CDIO curriculum continued during the 2001/2002 study year. The level of student reception was improved and the first CDIO project course was planned. From 2002, there is an engineering project (a CDIO class) in the first semester. The implementation of the CDIO curriculum has continued from 2002, with CDIO project courses in years three and four. From the description above, it is concluded that due to planned curricular changes, the study contexts of the students are changing [18][19].

## RESULTS

From the start, there were 10 students interviewed in each cohort: five men and five women. The results are based on interviews with *successful students*, ie those who have remained in the programme after the first year. The main categories deduced from the theoretical framework are as follows:

- Previous experiences;
- Approaches to learning and studying;
- Perceptions of the study environment.

The results are focused on the *variation between the cohorts*, which means that the similarities within and between cohorts, as well as variations between individuals within the cohorts, are not elucidated. The results are discussed below in relation to the theoretical framework.

### Previous Experiences

The 1998 cohort had personal experiences of failures in secondary school, new motivation to study from adult education, manual work experiences and being made redundant. However, there were also students who were used to being among the best in their class at the secondary school level. The 2002 cohort had experienced competition and focused on achievement in secondary school, and recognised that schooling could ruin a genuine interest in a subject. They had limited personal experiences of work life and thought learning came natural to some people as a sort of personal capacity that was mediated by a context. Their personal and social contexts were rather homogeneous and narrow.

### Expectations

The 1998 cohort expected a tough start in a tough programme and a lot of hard work, but they also expected education to be a

path to a good life and career in the future. The 2002 cohort also expected a tough start, which they expressed as *long days at school*. They felt very insecure about the future and had therefore chosen a broad programme in order to keep *all doors open* for as long as possible.

### Motives for Studying

The motives of the 1998 cohort was to meet the expectations from *society* to be well educated, but also to test their personal limits to see if they could manage a tough programme. The aims and goals of this cohort were aligned to those of *society*, as well as the traditional engineering curriculum. As the future was very vague and blurred for the 2002 cohort, so were their motives for studying. These were articulated more as optional exclusions than options (they did *not* want to engage in routine, manual work). Continuing *school* was taken for granted and they wanted to test what the programme had to offer. They created their personal life-space, while also keeping *the realities of life* at a distance.

### Students' Reflections on Their Teaching/Learning Environment

According to Entwistle, students' previous experiences, expectations and motives for studying will influence their approaches to learning and studying, as well as their perceptions of their study environment [2]. Trigwell and Ashwin argued that a crucial question for student satisfaction, achievement and retention will be the degree of alignment between students' motives and goals, and the motives, goals and intentions of the programme, ie their perceptions of the study environment [3].

Two recurring features of the 1998 cohort is that they have learned to *cram in* anything and that the examinations trigger students' interpretations of what the goals of the faculty are. Students believed that the first tough start was intentional so as to sort out the *deficient* students. The hurried pace was also interpreted as one way to sort people out. This interpretation was reinforced by a perceived change in attitudes from faculty after the first year. Students believed that the intention now was that those who remained should learn to be more and more autonomous learners. This influenced and triggered students' levels of motivation. Applicability and their future employability were not considered to be high on their agendas, and this became more and more of a problem for the 1998 students the closer they came to graduation.

For the 2002 cohort, *learning* came naturally to them and was mediated by the context. They expected to be energised and challenged by the studies and content, as well by peers and lecturers. The study context was a tool for them in the creation of their personal projects and failures were attributed to contextual circumstances.

### Situated Conceptions of Learning

According to Trigwell and Ashwin, a situated conception of learning is evoked and adopted by students in response to their learning tasks in a particular context [3]. The situated conceptions of learning in the 1998 cohort, established during the first two years, was that *learning* was to *get the hang of it*, to *crack the code* in order to be able to cram in and absorb knowledge. Learning was associated with achievement and visible results.

After two years of adjustment, the 3<sup>rd</sup> year was perceived as a turning point. They expressed that as a delayed understanding of previous knowledge, that they now could integrate previous knowledge into new situations. This change was ascribed not only to the course content, but also to the change in attitudes of faculty, that they now could choose their classes, subjects and work schedule. Learning was now described as learning about their own learning in relation to their personal motives, motivations and driving forces.

For the 2002 cohort, learning was associated with lust, joy and fun from the start, along with alertness and energy. When they encountered problems and perceived *learning* to be cramming and memorising, they experienced a friction between their own perceptions of learning and the intentions of the programme. Nevertheless, the first project course was experienced as a break among boring subjects! Learning was very much *associated with joy and fun*, with interest in a subject and providing challenges, and with something that makes one feel alert and energised. When *the programme* failed to meet this, their lack of motivation was projected into the study context.

## CONCLUSIONS

The concepts of the quality of learning, situated conceptions of learning and dissonance (or friction) are constructive tools for understanding and explaining the difficulties in evaluating the outcomes of an intended, planned change in a higher educational setting that experiences new and diverse demands from internal and external stakeholders [2-4][9]. The implementation of a general, standard based CDIO curriculum in a Swedish engineering programme has shown that there was a change in the quality of the previous learning experiences, as well as in students' anticipation for the future between the two cohorts.

The alignment between students' and teachers' previous experiences, aims and goals and those of the traditional curriculum was quite good after the first year, for those who remained after the tough start. The implementation of a CDIO curriculum was carried out with the best of intentions, but came at a time when there was a change in students' attitudes, as well as changes in external and internal demands on higher education. It should be noted that the fulfilment of curricular goals are, in themselves, not a guarantee of the quality of learning or of the attraction of students.

## ACKNOWLEDGEMENT

The project has been funded by a grant from the Knut and Alice Wallenberg Foundation.

## REFERENCES

1. Edvardsson Stiwne, E., The first year as engineering student - the experiences of four cohorts of engineering students in applied physics and electrical engineering in Linköping University. *Proc. 1<sup>st</sup> Annual CDIO Conf.*, Kingston, Canada (2005).

2. Entwistle, N., Concepts and Conceptual Frameworks Underpinning the ETL Project. Occasional Report 3. <http://www.ed.ac.uk/etl> (2003).
3. Trigwell, K. and Ashwin, P., An exploratory study of situated conceptions of learning and learning environments. *Higher Educ.*, 51, 243-258 (2006).
4. Meyer, J.H.F., Study orchestration: the manifestation, interpretation and consequences of contextualised approaches to studying. *Higher Educ.*, 22, 297-316 (1991).
5. Lindblom-Ylänne, S., Broadening an understanding of the phenomenon of dissonance. *Studies in Higher Educ.*, 28, 1, 63-77 (2003).
6. Prosser, M., Ramsden, P., Trigwell, K. and Martin, E., Dissonance in experience of teaching and its relation to the quality of student learning. *Studies in Higher Educ.*, 28, 1, 37-48 (2003).
7. Vermunt, J.D. and Verloop, N., Congruence and friction between learning and teaching. *Learning and Instruction*, 9, 257-280 (1999).
8. Vermunt, J. and Minnaert, A., Dissonance in student learning patterns: when to revise theory? *Studies in Higher Educ.*, 28, 1, 49-61 (2003).
9. Vermunt, J.D. and Verloop, N., Dissonance in students' regulation of learning processes. *European J. of Psychology of Educ.*, 15, 75-89 (2000).
10. Perkins, D.N., The many faces of constructivism. *Educational Leadership*, 57, 3, 6-11 (1999).
11. Meyer, J.H.F. and Land, R., Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines. *Proc. Improving Student Learning Conf.*, Brussels, Belgium (2002).
12. Scheja, M., Contextualising Studies in Higher Education: First-Year Experiences of Studying and Learning in Engineering. PhD thesis, Stockholm University, Department of Education (2002).
13. Prosser, M. and Trigwell, K., *Understanding Learning and Teaching: the Experience in Higher Education*. Buckingham: Open University Press (1999).
14. Eley, M.G., Changes in teachers' conceptions of teaching: do they prompt teacher development or are they outcomes of it? *Proc. 22<sup>nd</sup> Annual Conf. of the Society for Teaching and Learning in Higher Educ.*, Hamilton, Canada (2002).
15. Entwistle, N.J., McCune, V.S. and Walker, P., *Conceptions, Styles and Approaches within Higher Education*. In: Sternberg, R.J. and Zhang, L-F. (Eds), *Perspectives on Thinking, Learning and Cognitive Styles*. Mahawa: Lawrence Erlbaum (2001).
16. Lindblom-Ylänne, S. and Lonka, K., Individual study orchestrations of high achieving university students. *European J. of Educational Psychology*, 15, 19-32 (2000).
17. Högskoleverket (National Agency for Higher Education) Utvärdering av Utbildningar till Civilingenjör vid Svenska Universitet och Högskolor. Rapport 2006:8 R (2006).
18. Edvardsson Stiwne, E. and Stiwne, D., Expectancies and realities – evaluations and research on engineering students' experiences of their first semester. *Proc. ECER Conf.*, Edinburgh, Scotland, UK (2000).
19. Edvardsson Stiwne, E., Rosander, M., Stiwne, D. and Karlsson, A., Critical success factors in higher education - the first year. *Proc. ECER Conf.*, Lisbon, Portugal (2002).