Student involvement in principled change: Understanding the student experience

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Abstract

The CDIO Initiative is an international collaboration to reform engineering programs of each participating institution. Student representatives are actively involved in the process together with faculty and staff. In order to better represent a majority of students the student representatives initiated and carried out a survey of learning experiences among their peers. In the three participating Swedish engineering programs students were interviewed about their study experiences.

The student representatives discovered that they lacked a framework to interpret the interview data, and they were unsure how findings could be used to improve education. They teamed with pedagogical staff involved in the CDIO Initiative to link survey data to concepts from literature.

Frank quotes from the interviews are used to illustrate concepts such as deep and surface approaches to learning, assessment effects on learning, hidden curriculum, cue-seeking, motivation factors etc. This shows that theory is relevant to understand our context and improve education.

Based on evidence from the interviews we show how several aspects of course design affect student experiences of learning, and recommendations are made regarding changes. A separate "Top 10 list" of concrete recommendations was distilled in order to maximise potential dissemination.

1. Introduction

1.1 About the CDIO Initiative
The CDIO Initiative is an international collaboration to reform engineering education. The CDIO Syllabus[1] is a set of goals for engineering education, explicitly including personal, interpersonal and professional skills. It is the basis for curricular improvement in constructive alignment.

Members of the CDIO Initiative are Massachusetts Institute of Technology, Chalmers University of Technology, Linköping University, Royal Institute of Technology (KTH), Queen's University, Belfast, Technical University of Denmark and United States Naval Academy. Each institution is reforming at least one program.

1.2 Background of the study
In the CDIO Initiative, student representatives are working actively in the change process together with faculty and administrators. In order to better represent a majority of students, the CDIO student representatives initiated and carried out a survey of learning experiences. The same survey was done in the three participating Swedish engineering programs, Vehicle Engineering at KTH, Mechanical Engineering at Chalmers and Applied Physics at Linköping University.

However, after conducting and transcribing the interviews, the student representatives discovered that they lacked a framework to interpret the data. Most of all, they were unsure how findings could be used to improve education. The solution was to team with staff members involved in the CDIO Initiative. Together we have linked survey data to concepts from literature and to a previous survey[2] with the teachers of the same three engineering programs.

The aim with the collaboration was
- to help the students develop a framework to analyse student experiences and make well-founded suggestions for changes in course design.
- to send the message about necessary change from the students.
- to show that theories on teaching and learning are appropriate to describe our own students' experiences in our own programmes, and can be used to improve practise.

2. Method

2.1 About the interviews
The participating students were picked randomly from year one and four. In total 56 students were interviewed by the student representatives. Interviews lasted about one hour.

The interviews at Chalmers and KTH were done in groups, and the group interviews were audio recorded and transcribed. In Linköping the interviews were done one-on-one and recorded by taking notes. It turned out that the answers were very consistent among the three universities, independent of the interview format.

2.2 Questions

Questions were developed with the aim to make the interviewed students reflect on their own learning.

1. Describe your program: How do the courses generally work? What methods of teaching have you experienced?

2. What methods do you use to learn outside scheduled hours and how do they work?

3. What motivates you in your studies? What influences/decides - how much you study? – when you study? – the kind of study task you do?

4. What do you feel is the focus of learning in your classes now? Does this focus help you? Do you feel that you can apply your knowledge afterwards? What kind of focus would improve your learning?

5. What is it that defines the course to you? How do you know what to study and when you have succeeded? What if different sources say different things? What are most important?

6. How does the assessment influence your way of studying?

7. Do you feel efficient while you study or do you think you could do more/better? If so, what could change your way of studying?

8. Have you had any classes that have especially inspired and motivated you? How did the class accomplish this? Did it enhance your learning in that subject area?

9. What changes or other learning methods would you like to see implemented in classes to improve your learning?

3. Analysis and selection of topics

Upon reading the interview transcripts, we noticed that certain topics permeated the students' answers. **Assessment** was the dominating topic - in fact, it didn't matter much what the original question was, the answers almost always concerned some aspect of assessment. The second most common topic was **Motivation**. We also identified the topics **What defines the curriculum**, **Approaches to and quality of learning**, **Interaction** and **Time/Planning.** The analysis of the topics **Interaction** and **Time/Planning** are not included in this paper. All these topics are of course interdependent.

For each topic we looked for theory to provide a framework for interpreting the students' statements. We chose to read literature which was fairly accessible to engineering students with a keen interest but without any formal education in pedagogy:

- John Biggs, Teaching for Quality Learning at University (1999)
- Graham Gibbs, Improving the Quality of Student Learning (1992)

- Graham Gibbs, Using Assessment Strategically to Change the Way Students Learn (from Assessment Matters, ed. Brown & Glasner 1999)

4. Topic: What defines the curriculum?

4.1 Summary from literature
How do students decide what defines the course? Do they read the course objectives and other official information about the course, note what is said in lectures, read the literature, do the coursework or study old exams? What sources are most important?

The extent to which students were cued in to the assessment system is a strong predictor of their overall performance. **Cue-seeking** or cue-conscious students will work out hints about examination, they will find out what is the hidden curriculum.

Students quickly learn to see behind the formal curriculum (as expressed in the course objectives) and orient themselves to **the hidden curriculum**, which is defined by what counts in assessment. It can be very different from the official curriculum, which often aims at a higher level of understanding.

In summary: It is not curriculum which shapes assessment; it is assessment that shapes the curriculum. Or even: **Unless assessment tasks mirror the curriculum, they will erode it**.

4.2 Results from interviews
The **course objectives are not used** as guidance by the students. This result was expected, as most courses in these programs had objectives written in formats like: "students should be able to understand...". The course objectives are considered "fuzzy" and the students aren't able to determine when they have reached the objectives. Instead, they focus on other sources that are more important to them:

- The course objectives are very unclear and they don't give that much [guidance]. It's pretty hard to know what 'good knowledge' is. By testing yourself on previous exams you get a clear picture of what you know.

- The course objectives are so huge; the lecturers bring up what is most important.

The **course literature** is mentioned by a few students who have a special interest in the subject, but many do not read the text books. Many students follow the **coursework schedule** (recommended problems to solve each week). But it is overwhelmingly clear from the interviews that **what really counts is the assessment**. Assessment shapes what the students are oriented towards in their learning. The exam has the **overriding importance** over anything else, be it the course objectives or the recommended coursework. Many students report that they are cue-seekers, trying to **find out what will be assessed**, in order to concentrate on that. Cue seeking is also done **collaboratively**. All students **study exams from the previous years** in order to understand what is important in the course. Lectures are also an important source of cues.

- You focus on the exam. If you know what the exam will be about, you will study that.

- I look in old exams for typical exam tasks and learn those.

- If you don't go to the lectures, you'll miss what is considered important. Then you have to study all of it.

- The goal is set by what will be on the exam, which in turn is based on what the lecturer says during lectures.

- Before the exams it feels good to work together so you know that you don't do the wrong things.

In summary, students strategically orient themselves towards **the hidden curriculum**, which is defined by assessment. This would not be a problem if assessment was properly aligned to the objectives, but in reality the hidden curriculum can be **very different from the official curriculum**.

- I'm sorry. The exams aren't always so difficult and you can actually make it through [university] without knowing very much.

- To get a higher grade you need to be able to solve the problems that are different each year, but to pass you only need to practice on five previous exams.

5. Topic: Assessment

5.1 Summary from literature
Assessment dominates in several ways what students are oriented towards in their learning. It affects student learning by
- Communicating, or rather: defining, the intended learning outcomes.
- Generating time on task.
- Distributing the time spent working during the length of the course.
- Generating the kinds of learning activity the students will do.
- Providing feedback on progress.
- Affecting what learning strategy students will adopt (deep or surface).

Constructive alignment is when teaching and assessment are in harmony with the objectives. That means that the strong influence that assessment has on student learning is used as a positive force. Assessment will support student learning in a beautiful way when the assessment tasks generate appropriate learning activities, help students getting started and keep working across the course, give early success which drives motivation, and provide timely feedback that the students pay attention to.

On the other hand, badly designed assessment will be a strong negative force. **Unless assessment tasks mirror the official curriculum they will erode it**. The **hidden curriculum** is shaped by the assessment requirements. This can be very different from the official curriculum, if the assessment system rewards a lower level of understanding than the intended learning outcomes.

5.2 Results from interviews
Students reported that final exams made them **postpone their studying** until the last moment. A previous survey[2] has shown that all courses in these programs have final exams (with only a few exceptions in Linköping). The message came through very clearly:

- In a course with a final exam you feel that learning the content can wait, and then you don't spend so much time.

- Some courses you neglect until the week of the exam. You can actually cram in some courses in a few days.

- I think final exams are hard, because then I think that it's not until six weeks later that I need to know this, and I can relax until then.

- I can think that this time I will start early and do a little each day. But it has never happened so far. (student in the fourth year)

Assessment tasks early in the course help students **getting started** with their own work in the course. Giving the necessary igniting spark is an important function of assessment. Many students report that continuous assessment helps them **spend more time** on the course. The pressure from deadlines makes the students keep up. Students also report that they **learn better** from doing coursework during the course than from intense cramming for exams. We think this is because they spend more time on task, but probably also because coursework seems to lead to more effective study habits.

- Tasks that you have to do during the course makes you start studying and you get into the subject earlier.

- If you have deadlines all the time, then you spend time on the subject.

- When assessment is spread over the whole duration of the course you learn better.

In summary, continuous assessment tasks helped students get started, made them spend more time on the course and also learn better. However, some students feared that the **total workload could be overwhelming** if parallel courses have continuous assessment.

- If you would have three courses in parallel which don't have final exams you would be totally burnt out.

How the assessment is designed will also **affect the kind of work** the student will do. One example which is mentioned is **aids in exams.** Examples of aids are textbooks, books with formulae, or the student's own notes. An **exam where aids are not allowed can encourage students to adopt a surface approach**, because they focus on memorisation instead of understanding. Being allowed to bring aids will change how and what students do to study before the exams, as memorisation is no longer necessary or relevant. Another important consequence is of course that the teacher cannot construct the same kinds of questions for open book exams.

- In the first years you are mostly not allowed to bring any aids to the exams. Then you don't focus on being able to apply this knowledge afterwards, but more on what you are supposed to learn in the course.

- I once wrote an exam where you were allowed to bring 'everything'. There you had to first understand the problem, and then how to solve it. I think that feels more useful.

6. Topic: Motivation

6.1 Summary from literature
The expectancy-value theory of motivation cites two factors that make students want to learn:
1. They must perceive the topic to be important; it must have some **value** to them
2. They must expect that it is possible to accomplish the task; they must **expect success**.

Motivation is the result of these factors multiplied. If either of them is zero, then motivation is zero. There are four dimensions of value that the learner can assign to the task:

- **Intrinsic motivation**: performing the task driven by their own interest. The task itself can bring immediate satisfaction, or it will contribute to future satisfaction. Intrinsic motivation is strongly related to a deep approach to learning. Students experience a need to know; they have ownership over their own learning; it matters to them.
- **Social motivation**: performing the task in order to please others whose opinions are important to them. Social motivation is a good precursor to intrinsic motivation. Teachers can create social motivation, and the social dimension of many learning situations can increase motivation, as it is important to students to look good in front of peers and teachers.
- **Extrinsic motivation**: performing the task because of the value they attach to what the outcome brings. The outcome itself is more important than learning. The task is something that has to be got out of the way in order to pass the course, receive the student loan etc.
- **Achievement motivation**: performing the task in order to compete and win. Here, learning is less important than winning, and the task must be handled as grade-effectively as possible.

What about the second factor then? What will influence a learner to expect success or failure? **Previous experience** will influence expectations. After success, the student will expect to succeed again, if the conditions that are believed to lead to success are the same. **Clear goals and criteria** are important to make it possible for students to expect success. Students must know where they are going, and know what work they have to do in order to get there. Expectancy is at risk if the course communicates unclear or unreasonable goals, for instance when trying to cover too much content. Giving students **feedback on progress** early in the course is important. Formative assessment will help students get started and keep working, and offer a chance of "early success" which, in turn, enhances motivation.

6.2 Results from interviews
It is clear from the interviews that an **early success** in a course will spur motivation.

- If you get the right answer on a calculation assignment you continue with the next one and it gets fun. If it's difficult you get unmotivated and you spend less time on it. One should really put more time into things that work badly but it doesn't work that way.

- When it works well it's easier to study and then the whole course feels more meaningful.

Two kinds of motivation seem to matter most to the students: **intrinsic motivation** and **social motivation** are mentioned very frequently. Intrinsic motivation is very satisfactory. Some

students bring intrinsic motivation with them when entering the course, but students note that it can as well be created during the course.

- The interest for the subject is the most important. It can be a prior interest or it can be created during the course.

- With some courses I can feel 'Oh no not another math course'. But then you get some understanding for something in that course and then it suddenly feels great fun in a way.

- I spend much more time on courses that feel relevant to me, but at the same time less, because it's easier for me to pass these exams.

Reaching a deeper level of **understanding** is clearly desirable to the students. What is mentioned above all is **being able to apply** knowledge. This clearly gives a sense of ownership. On the other hand**,** rote learning is perceived as boring.

- Knowledge is motivating. Being able to answer a question makes you feel motivated and you think it's fun.

- [These] courses are interesting because we solve problems. Then you learn better and it's more fun. They are also better connected to what I want to work with and that's why they become more interesting.

- Some courses are very theoretical and based on rote learning. They tend to be very boring.

- In the fourth year courses focus more on problem solving, which is very satisfying to be able to do on your own.

The influence of **the teacher** is considered extremely important. A "good" teacher is often mentioned when the students are asked to describe a course that especially inspired and motivated them.

- In [one course] the teachers were carefully chosen and really wanted to share what they were doing. Then it was so fun that you almost want to go on over the break and just hear more. In other courses the teacher seems almost forced to stand there.

- Some lecturers made you interested in their subject. Some failed completely, so you thought that you never want to take that subject.

- It depends totally on how the lecturer is, the subject itself can be so and so.

In many cases**,** the social motivation also comes from **peers**.

- Having study mates helps you getting up in the morning to go to school.

- In one course we had calculations as homework twice a week. Every time the teacher picked a student at random who had to present the week's homework. This gave motivation [to prepare], because you did not want to stand up and say that you couldn't do it.

When all else fails, **extrinsic** motivation is also present.

- Totally honestly, you often study just to pass the exams. Sometimes the subjects are interesting but not enough to give the energy it takes to learn all of it.

- When you start on a job you will do completely other things anyway and the education is just to prove that you are able to learn and understand things.

- You study just to get the credits so the money keeps coming.

- In certain courses you feel that you don't want to learn more than what it takes to pass. I feel that there is nothing in [course] which I will have used for and that I find interesting.

7. Topic: Approaches to learning / Quality of learning

7.1 Summary from literature
Students have different intentions driving their learning. Trying to achieve different things, make them go about their learning differently. Two extreme approaches to learning are identified: surface and deep approach.

In **surface approach** the intention is to reproduce the subject matter, typically in an exam. The focus is on isolated facts; items treated independently of each other. This prevents students from grasping the meaning and structure of the subject; they see trees, not woods. Emotionally, learning becomes a drag, a task to get out of the way. Memorisation is a surface approach when used to fake understanding. Knowledge is poorly structured, and rapidly forgotten. It is possible to achieve a good grade using the surface approach, as long as the assessment system rewards rote learning. But exam results do not predict long term retention. The reason for this can be that intensive revision for exams involves a surface approach.

In **deep approach** the intention is to make sense of what is learned. The focus is on underlying meaning: on main ideas, themes, principles or successful application. This requires a sound foundation of relevant prior knowledge, so students will naturally try to learn the details, as well as making sure they understand. When using a deep approach in handling a task, students have positive feelings. A deep approach is likely to result in long-term retention. Coursework results are a good predictor of long term recall.

An approach is not the same thing as a skill or characteristic of the student. Instead, **most students can adopt both surface and deep approaches** to their learning, responding strategically to the perceived demands of the course or task. Inappropriate course design, teaching methods and assessment can foster a surface approach.

7.2 Results from interviews
Many students describe using **a surface approach.** They describe **ineffective study habits** when concentrating their studies to the end of the course or when they study old exams. Memorisation is used as a substitute for understanding. This is bad for motivation and long-term retention.

- Most courses are based on learning by heart. In the first years you are mostly not allowed to bring any aids to the exams. Then you don't focus on being able to apply this knowledge afterwards, but more on what you are supposed to learn in the course.

- Take away rote learning, you loose it quickly anyway. More understanding!

For a majority of students **the route to understanding is through application**, not through derivations and theory. The focus of many courses is seen as mainly theoretical, and many students point out that **theory is memorised for the exam** rather than applied and understood. Interviews[2] with teachers have shown that practically all courses have a bottom-up approach, starting with theory, and only after that problem-solving and practical application. Apparently this is badly received by the students:

- In some courses you are supposed to know every little step of the derivations. It feels unnecessary, it would be better to know how to arrive at something than learning it by memorisation.

- We should move the focus more to application, to get a grip on what it's all about. I don't feel that I can apply the knowledge I have.

- Connection to real problems is good. You don't want to sit there with a theory cake which you cannot eat from.

- What the teachers want to know is you've studied the theory. You often study for the exam and then forget. Instead of focusing on why and how you do something, it is much rote learning.

- The new [course] really got an understanding approach and you're allowed to bring books on the exam. Knowing by heart is really useless. It is much more fun if you understand, and you remember much more.

- I want to see the practical use before theory, because that motivates the theory.

One quote shows that the same student can use **both a deep and surface approach** in the same course. Here the strategy adopted **depends on the assessment task**: coursework is done with a deep approach and cramming for the exam is done with a surface approach. This student also observes how a deep approach results in long-term retention:

- The things I remember from a course are the parts we had assignments on. Then I really sat down with the problem and worked out the solution myself. If you work on old exams you check up the correct answer too quickly and then move on without really learning.

Another reason to take a surface approach is **time pressure** due to **content overload**, which the students think is very common.

- I think they want us to learn a lot of unnecessary things 'just in case'.

- Many courses dig too deeply into a subject for [the amount of] credits. They include too much and you only have time brush against the surface of a huge subject.

- Of course you should really know all of it to be a good engineer, but it just isn't possible.

Some of the students, especially in their fourth year, have clearly found intrinsic motivation. It seems that their **deep approach to learning is effective**.

- This is really my dream education because I want to design vehicles. I spend much more time on the courses which feel relevant to me, but at the same time less time, because I pass the exams easier.

- In year four you understand more about what you're doing, you absorb knowledge much better when you know how it can be used.

8. Conclusions and recommendations

The results show that concepts from theory are indeed appropriate to interpret student experiences. We have let frank interview quotes illustrate the concepts, to show that the theory is relevant in our context. By applying the concepts we also improve our own understanding of them. Based on the evidence from the interviews, we have identified certain problematic practises in the education programmes. Supported by the literature we then recommend some changes to the courses. A separate "Top 10 list" (Appendix A) of concrete recommendations regarding changes was distilled in order to maximise potential dissemination. We have focused on such changes that are within the power of an individual teacher.

9. References

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10. Acknowledgements

Appendix A. Top 10 recommendations

1. **Set clear objectives that are relevant to the engineer: "After this course you will be able to..."**
   This will increase motivation.

2. **Design assessment tasks and teaching that are relevant to the objectives.**
   This will define the course objectives to the students and engage them in the appropriate learning activities. Motivation is strong when students experience a need to know things in order to carry out tasks that matter to them.

3. **Focus on working knowledge of basic concepts and provide connections to reality. Application is the road to understanding theory.**
   This will encourage a deep approach to learning by increasing intrinsic motivation, giving better understanding and long-term retention.

4. **Prioritise. Remember: coverage is the enemy of understanding.**
   This will reduce time stress, which is an important reason why students adopt a surface approach to learning.

5. **Set an assessment task early in the course.**
   This will help students getting started and provide an opportunity for early success, which is a motivation factor. Getting feedback in a timely, effective manner, will help students learn.

6. **Set assessment tasks regularly during the course.**
   This will help students spend time on tasks and keep up the pace of work. Getting feedback and responding in a timely, effective manner, will help students learn.

7. **Produce explicit criteria for assessment. Make sure students know exactly what is expected of them.** This will take away the hidden curriculum and reduce the cue-seeking game.

8. **Design tasks and activities with built-in interaction. Use both peer interaction and student-teacher interaction.**
   This will increase social motivation and encourage deeper understanding.

9. **Make a realistic plan for the time the students spend on the course. Get regular feedback on the actual time spent on tasks. Coordinate deadlines and workload with parallel courses.**
   This will reduce time stress.

10. **Show with your enthusiasm that the course and its tasks are worth doing.**
    This will promote social motivation.