LEARNING TO LEARN, BOLT-ON, OR INTEGRATED?

ANALYSIS OF STUDENT FEEDBACK FROM A PILOT WITH LEARNING TO LEARN INTEGRATED INTO FIRST-YEAR ENGINEERING MATHEMATICS.

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ABSTRACT

Learning to learn is one of the generic skills that are important to becoming an engineer. One outcome of the education is to be prepared for a role as an engineer with lifelong learning. In this paper, I convey experiences gained from two different approaches when implementing "learning to learn" into engineering math courses. The first approach, learning to learn was added to a mathematical course as a "bolt-on" approach in two initial pilots. A second approach was to include learning to learn in the course. In this approach, I wanted to utilize feedback cycles and provide information on learning to learn "as needed".

Interviews of students and experiences from the pilots have been analyzed using thematic analysis. Two different experiences were described by the students in the two classes that were included in the pilot. In one group, the smallest of the two pilot classes, not a single student dropped out in the remaining three-year of the study program. The program had a major impact. The other group, the biggest class, was more resistive.

In the second approach, I wanted to utilize the role of a mathematics teacher. Here I could use the authority and the relation as a math teacher. However, introducing learning to learn as a teacher conflicted with the role as a teacher. Here I discuss key findings from four focus group interviews, in addition to my experience as a teacher, that can help to plan future course design when learning to learn is included.

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1 INTRODUCTION

1.1 Introduction

Higher education requires efficient learning. But learning in higher education is complex, it is a personal development process, and involves a change of perceptions, learning habits, and epistemological beliefs [1]. It is well known that the transition from school to higher education is challenging since students often lack an understanding of the kind of learning that is required [2, 3]. Wingate [1] claims that two things have to be present for efficient learning in higher education. Firstly, students must understand learning and become independent learners that take responsibility for their learning. Secondly, to understand the knowledge and become competent in constructing knowledge within the discipline.

A theory that focuses on what the students can do, and hence is relevant as a toolbox is self-regulated learning [4] and related constructs. Self-regulated learning strives to understand self-regulation, as an active learning process and how it is used to actively pursue individual goals. Self-regulated learning refers to the modulation of affective, cognitive, emotional, and behavioral processes throughout a learning experience, to reach the desired level of achievement [5-7]. Research has shown that self-regulated learners are autonomous, reflective, and efficient learners who have the cognitive and metacognitive abilities as well as the motivational beliefs and attitudes needed to understand, monitor, and direct their learning [8].

Learning to learn (LTL) or developing lifelong learning skills is one of the many generic skills that is envisioned integrated into the study programs at NTNU The question is, how could this be done? A common approach is to hire an expert in learning from outside the faculty, that can teach how to learn. However, these generic, often in separate 'bolt-on' courses [9] are often found to be inefficient. Another approach is to include elements of LTL in the course, challenge the learning process, and provide information according to needs throughout the course.

The results presented here are from two pilot periods. The first period with a bolt-on design, and the second period, with an integrated design where the author integrated LTL in a qualification course in mathematics. Here I discuss results considering my experience gained from the two different approaches to embedding LTL.

1.2 The context

In the first test period, in the autumn of 2014, LTL subjects were integrated into two mathematics courses in a first-year bachelor of engineering mathematics course. Subjects from SRL that were considered relevant to learning, were introduced in a weekly 20 to 40 minutes lecture as a part of the mathematics lectures. The LTL lecture was an additional hour added to the timetable of two math courses, but the subjects were presented by the author and not the math teacher. The concepts introduced to the students were; goals how and why, self-regulated learning in general, work habits, ways of thinking, memory, bulked vs spread practice, self-testing and retrieval practice, implicit theories of intelligence [10], motivation, reflection, self-efficacy, teamwork, and exam preparation.

In the second test period, the author entered the role of a mathematics teacher. Here LTL subjects were initiated by problems that students encountered during their process of learning mathematics. Frequent assessments with integrated reflection forms were used as a source to gather information about the challenges that students faced. No interviews were made and hence the data from this period are only from my own experience as a teacher attempting to integrate LTL in a math lecture. The difference between the two designs was that I changed my role from a bolt-on-teacher to a mathematics teacher. The level in the second design was a qualification course with 12 hours a week of contact. Entering the role as a teacher in the second period was a wish of the author, to establish a closer relationship with the students.

In both periods, learning-to-**learn** was linked to a feedback cycle in what we called classroom assessments, a design inspired by Nicole and MacFarlane-Dick's [11] recommendations on feedback. A classroom assessment consisted of a 1-hour test, where students worked individually to solve problems without any tools. In the last 10 minutes of the test period, students were given alternatives and the results were submitted electronically. After the test, scores were given, followed by an immediate review of the problems, prioritized by the average score on each task. Here the students could correct and pick up immediate feedback. At the end of the assessment, students were given a reflection form, where they were asked to observe reactions to the problem solving, and reflect upon goals and progress. Parts of these reflections were collected and included in the LTL sessions the following week. The second test pilot had a significantly higher frequency of tests than the first and the period lasted for a full year.

2 METHODOLOGY

In the last week of the first test period, four semi-structured focus group interviews were performed by a fellow faculty member. 5 female students and 6 male students participated resulting in 4 hours of interviews that were transcribed. The data corpus, in addition to the interviews, consists of written assessment reflections, student responses in lecture interactions, and evaluations that were available for analysis but were not included in the dataset analyzed. The data set was mainly transcribed interviews.

Interviews were analyzed using a thematic analysis approach[12]. The content was organized in thematic groupings, reviewed, and reorganized according to extracts that essentially describe the student experience. Some relevant codes were structured by the interview guide and some by themes that appear.

In both pilots, every subject was introduced with questions, where students responded through a student response tool iLike [13]. This tool allows for text-based responses in addition to standard multiple-choice questions. As an example, initializing a lecture about motivation text response question "what do you experience as demotivating?" The next question was "What motivated you?" followed by the question "How do you regulate your motivation?" Throughout the lecture series the

"what can you do?" was a core concept. The purpose of this initiation was to connect to preexisting knowledge and ideas, for me as a teacher to see how they were thinking, and at the same time, allow students to interact with the content both before and during the lecture

3 RESULTS

3.1 Getting close

Entering a mathematics lecture and starting talking about emotions, does not feel natural for a physicist. There are shifting emotions related to learning mathematics. Emotions change dynamically between confusion, frustration, boredom, engagement, flow, curiosity, anxiety, delight, and surprise. One of the first questions that were asked in the lectures was, how do you agree with this statement "Emotions have nothing to do with learning and should therefore not be mixed with learning" only a few partly agreed 27% and around 60% disagreed. A surprising 17% answered I don't know. In the interviews, this focus on emotions and regulation of emotions became one of the biggest themes and seem to have been easiest to transfer to their own experience. Discussing experiences, emotions, and ways we think opens the door to a personal and private sphere. Allowing students to come closer, and at the same time, coming close to the students.

The superordinate theme of getting closer appears in all interviews in one way or the other. This kind of work with personal development, where thoughts and emotions are discussed, requires a safe space where it appears safe to discuss traits, reflect on learning, and discuss private thoughts. The experience of the students when you succeed is a sense of getting personal.

> *Everything gets more personal. We got a stronger relationship with the school. Instead of a situation where there is a lecturer that we don't even know the name of, is standing there, talking, and babbling about something.*
> - Male student 3 -

Asking questions about well-being and displaying results for the entire class, seem to have influenced individually. But revealing how others are doing also influenced the class environment:

> *It feels like the class environment got better from this.*
> - Male student 3 -

Throughout the semester I allowed students to come close to what I as a teacher was thinking, what I experienced, and the choices I had to make when facing challenges that appeared. Being open about reactions, and insecurity, and allowing for my thoughts and reactions to be bot considered and criticized was interpreted as "down to earth" or honest.

> *The thing is that he is really present and very personal with us. Then you automatically get people interested. He uses examples that we recognize from his life when he was a student, and that is relevant today also.*
> - Female student 1 -

This openness and honest communication lead to a sense of belonging

> *Everything becomes more personal. We got a better relationship with the school. Instead of a lecturer standing there talking and we don't even know his name… I feel that the class environment improved from it too.*
> - Male student 2 -

When the class accepted and created their rationale for why the interventions were there, the perceived effect was a sense of being cared for.

> *It felt like the faculty cared, in a way… because at other schools it's been like, if you fail you fail, bad for you!*
> *- Female student 3 -*

These are all factors that are important in the sense of belonging, an important factor for motivation according to self-determination theory [14]. The establishment of this relation to the class was a key ingredient to opening up for reflections on a private subject like learning.

3.2 Integration in a course vs. bolt-on solution

How do students perceive LTL as a part of the mathematics lecture? When asked about which subject is best suited to include LTL, the students are clear. It had to be entangled in an **important** course.

> *…mathematics is kind of hard for a lot of students, a lot of students have forgotten, and it is — yes it's a lot to remember in that subject, and it is a lot—*
> - Female student 1 -
>
> *And then it's kind of relevant since...*
>
> - Female student 2 -
>
> *But it is, after all, okay that it is given in the connection of a course*
> - Female student 1 -

Another aspect here is that since most students take the subject of mathematics seriously, integrating LTL into the math curriculum will make most students participate. They both appear to share the same experience that since mathematics is demeaning, a course that most students experience as demanding. According to the students, to get a sense of a shared development process, most students must participate. When asked, could it be a part of generic subjects like an introduction to engineering, the students immediately responded "no!"

3.3 Criticism / Resistance

Not all students participated in the lectures and the attendance in the additional lecture dropped throughout the semester. Most students reported that the time of the week, Fridays, was one major reason why they dropped out.

Some resistance lies in the individual beliefs that students hold about learning and how to develop these skills.

> *… I am kind of skeptical to these kinds of self-development-things —my meaning is that these kinds of things must appear from our own experience —*

> *in a way be learned on our own...*
> *My experience is that these kinds of things will appear in a way— and it will appear from the inside.*
> Male student 6

This statement was immediately contradicted by the female friend during the interview. But, there are elements of truth in this statement, you cannot force learning and development on students. Internal motivation is a better starting point than external pressure.

One type of criticism found was on the format. But this is also one part of the resistance you will notice when you introduce LTL without proper integration.

> *Even though I find the subjects interesting, I am very bad at trying them out without having the motivation to do so. I would like to have a challenge or something, just to try it out.*
> - Male student 6 -

Learning activities where students must participate and in learning activities that should be closely linked to active learning situations where the learner is engaged in thinking, learning, and performing.

> *It depends on how willing you are to accept it, I think. I feel that the entire purpose of the project is to get this self-awareness. You cannot sit and listen to someone telling you how your self-awareness should be. … but he has been good at giving us the tools, he has just not given us the chance to use them.*
> - Female student 4 -

This student reported in the interviews, that she had been reading about study strategies and had an interest in developing her skills, which in it selves an autonomous activity. She says she has been given the tools, but given the chance to use them. It is expected that if she was to use the knowledge we had to require and provide a learning activity where she could use them.

4 SUMMARY

There are several known barriers to implementing LTL in higher education [15]. Instead of accepting the responsibility for educating everyone, the easy way out of the challenge is to explain the lack of student success to the student readiness. When the challenge is taken, the easy way to fix the problem is a bolt-on solution that is cheap seen from an economical point of view. One external expert can be hired, to give excellent lectures on learning in general. An expert might have deep knowledge about learning and provide up-to-date information about learning. The other advantage, lectures are released from the responsibility to help students to develop their learning and may spend more time on research. There is a lot to learn when a lecturer starts shifting from a transfer of knowledge model to start feeding and informing students in their process of learning. However, relying on external experts does not shift the institutions' way to teach into a focus on how to facilitate learning.

Picking up the glove and accepting the responsibility for the students learning process, is the first barrier [15]. However, it is worth noticing that facilitating the development of the students learning process is not something that is done without resistance. Priorities at the universities are often directed toward research. The easy way is to initiate a bolt-on solution, where external experts in learning are hired to remedy a need. University teachers as representatives of the domain that we invite our students into are also authorities that make information about how to enter the domain more relevant. The main challenge here is that we repeat what worked for us, lecturing.

> *It's like—what he asks for us to do, is to invest in his ways of thinking...*
> Male student 5

Students prefer to continue to work and do things in the way that they perceive as their model for successful learning, rather than taking the risk to spend time on something that may not work, which requires extra effort. Investing in new ways of working, and experimenting with ways of thinking that might not give immediate results is experienced as a risk. The same is true for teachers that give lectures or facilitate learning.

Who else other than representatives of the domain, the faculty, are more trustworthy of what ways of thinking are needed to enter the domain? However, the faculty must value learner development in addition to the learner's curriculum. In a healthy learning culture, the entire institution should engage in a culture where the students learning process, and experience with learning is in focus. If the faculty use a dialog with students as input for development and learning, students will find an improvement culture more relevant and natural. Keeping the development culture inside the institute is important for continuity in these developments.

Criticism was given on only teaching LTL and not allowing students to "try" techniques. First, it is known that knowledge about the health effects of physical exercise does not automatically create more physically active behavior [16]. The problem of translating knowledge about the benefits of an action does not create a change in what people do. This is known as the knowledge-behavior gap. The same effect might also be present when it comes to the way students learn. Knowing how to study, does not necessarily make students change the way they study. LTL activities have to be integrated into learning activities. In the second period, a stronger link between assessment and reflection schemas was considered more natural. Secondly, learning is more than a technique! Learning to learn is to know and understand oneself and be willing to challenge reactions, patterns in ways to think, and ways to work. It is an agentic search for better ways to interact with the learning process.

The overall purpose was to make students more aware of their learning process. It appeared as an opening ut a safe space where it is safe to talk about how we think, experiences, feelings, and thoughts seemed to be essential to initiating the LTL process. The use of response technology was a key ingredient to picking up

information and simultaneously creating a sense of interaction with large groups of students on rather private subjects that LTL is. Technology allowed students to see how other students were thinking about central topics, thoughts, and reactions of others were perceived as an effective element to both inform and create a sense of belonging.

> *We got to know each other through these survey questions, even though we answered anonymously.* - Male student 2 -

Finally, LTL, applying the knowledge, and gaining experience as a learner takes time. For some students, the first exam is real feedback. Then they know for real how their learning worked. This requires constant focus throughout several courses and not just a one-time intervention.

In the second period, LTL lectures were given as a part of a feedback cycle from the author as a mathematics teacher. The feedback cycle was initiated from improved and varied reflection schemas. LTL subjects were chosen according to what students discussed in their reflections about learning. But, here there was a conflict on how to spend the time as a mathematics teacher.

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