INNOVATIVE METHODS FOR ENTREPRENEURSHIP & LEADERSHIP TEACHING IN CDIO-BASED ENGINEERING EDUCATION

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ABSTRACT
This paper focuses on mixed methods for teaching and learning; with special emphasis on individualized learning and engagement of students for reaching better results and relevance in CDIO-based engineering education. Four types of learning activities are discussed in the paper; i.e. “flipped classroom”, “experiential learning exercises”, “sharp live cases” and “theory-based practical exercises”. The empirical material is drawn from the authors’ own teaching experience. Based on a literature review and our own experience, we propose a model with components crucial to take into account when learning activities are designed and practiced. These components are stakeholders, pedagogics, technology and context.

KEYWORDS
Entrepreneurial learning, Flipped classroom, Blended learning, Live cases, Experiential learning, Standards: 7, 8, 10

INTRODUCTION
Integration of topics such as entrepreneurship and leadership within CDIO-based engineering education is a challenging task for teachers, program leaders and coordinators. A major reason for this is that just teaching and studying theory is not enough to achieve competence in this area.

At Linköping University, Department of management and engineering, we give courses in entrepreneurship and new venture development, innovation, organization, leadership, project management and marketing. Our courses are included in most of the engineering programs given at Linköping University, either as mandatory or elective, and engage about 2000 students on an annual basis. Today, we have more than ten years of experience in designing our courses with inclusion of a variety of learning activities. This variety is based on the premises that learning should be student focused and that students have varying individual learning preferences (i.e. four different learning styles: reflectors, theorists, pragmatists and activists; as described in Kolb 1984). We also argue that relevance, passion and “fun factor” enhance learning.

Alongside face-to-face traditional lecturing, we therefore work with a mix of tools and approaches to enhance student learning. In this paper, focus will be put on four types of
learning activities, i.e. sharp live cases, experiential learning exercises, flipped classroom, and theory-based practical exercise material. These methods are useful for CDIO-based teaching and learning within areas such as entrepreneurship and leadership where development of skills, attitudes and making sense of context are integral parts of the learning process. A mix of methods is also advocated in several studies as being valuable, see e.g. Fayolle and Gailly (2008), Politis (2005) and Gibb (2002), not least since this mix of methods enables learning of a wider range of skills and the integration of thinking, feeling, perceiving and behaving within the learning experience.

This paper is mainly based on our own teaching experience and the aim of the paper is to describe the activities “Flipped classroom”, “Experiential learning exercises”, “Sharp live cases” and “Theory-based practical exercises” and share how they are used and combined in our courses. We will also discuss students’ experiences and results as well as experiences reported in the literature on entrepreneurial, experiential and blended learning.

THEORETICAL BACKGROUND

People are different, think different, prefer different and have different abilities and solve problems in different ways. In the light of this human diversity we all learn in different ways, see e.g. Kolb (1984). Some prefer to read alone in quiet rooms, others learn in groups through interaction and discussion. Some are active in the early mornings and others work late nights. Some want to combine different sources of knowledge, while others want one book. What is right and what is wrong cannot be told. At a university in the forefront, it is of high importance to be able to meet people in their learning processes where they are. This approach implies that several forms for learning are used. One buzz-word describing this is the term “blended learning” which is frequently discussed in recent literature, see e.g. Garrison & Kanuka (2004), Ginns & Ellis (2007) or Lopez-Perez et al, (2011). According to Garrison & Kanuka (2004), the term blended learning, in its simplest form, is a mixture of traditional face-to-face learning and e-learning. However, it could, according to the authors, be made more complex than that. The key word is combination, and since we lack of a clear concept we will from here on talk about mixed methods for learning. Besides meeting with different learning styles, we believe that inspiration is a vital force to stimulate learning and curiosity. This is manifested in the second, out of five, principles for learning launched by MacInnis, Ramsden and Maconachie (2012); "interest and explanation", i.e. to make the subject interesting and challenging to the students. However, for a teacher to be able to inspire, teachers need to be engaged, which in turn calls for support and recognition also from the university. The fifth principle launched by the same authors is the importance of involving students. This factor is also put forward as success factor within studies of blended learning. For example Garrison & Kanuka (2004) write: "What makes blended learning particularly effective is its ability to facilitate a community of " (p. 97).

From a general educational perspective, there are different approaches to learning that often takes place in a system with different levels of components. A traditional way of teaching is a lecture where the teacher teaches the student by some kind of “osmosis”. An example is reading out loud and the students strive to remember what the teacher says. According to this view, knowledge is seen as a product and the task of the teacher is to be the transmitter. According to Svedberg (2000), knowledge creation in stead could be regarded as processual. Following this view, the teacher is seen as facilitator and the students as co-creators of the knowledge, and the learner constructs her own learning. One example of a systems supporting high-order learning that takes this perspective is Biggs (2003) “constructive
alignment”, where the teacher should act as a catalyst and create a learning environment that supports learning effectiveness. The key to success is to align learning outcomes to all teaching activities. There are two major processes, first identifying intended learning outcomes (ILOs) and then choosing teaching/learning activities (TLAs). This could be illustrated through the traditional quote: “Give a fishing rod rather than a fish.”

Coupled to the above-illustrated perspectives on learning, teaching models such as “entrepreneurial learning” has been put forward. Entrepreneurial learning is, according to Politis (2005), synonymous with experimentation. Gibb (2002) also writes about entrepreneurial learning and demands for “creative destruction” in order to create a more activity-based learning. Activity enhances involvement and thereby also engagement. Peirce argued already in 1878 that knowledge is not a product, but instead an activity (Peirce, 1878). According to Pierce, knowledge is created through doing things, not watching things being done. Dewey is recognized for his theory of knowledge development that departs from the idea that knowledge only could be obtained through action (Dewey, 1899). Also the literature suggests that practical appliance is needed to obtain deep understanding of a subject. As example could be mentioned Arbnor and Bjerke (1977), where the student is mentioned as knowledge creator, rather than capturer of knowledge. Furthermore Whetten in 2007 wrote: "Regarding higher level learning objectives, a common concern raised by teachers, especially those teaching particularly difficult subjects, is that students can’t apply something they don’t understand. Although this is true, it is also true that students achieve a deeper level of understanding when they are required to apply what they are learning.” (Whetten, 2007, s. 345)

During recent years, another pedagogical buzzword has appeared, namely the so-called “flipped classroom” approach. Bergmann and Sams at Woodland Park are regarded as those who invented the concept “flipped classroom” 2007 (White, 2011). The concept implies that lectures are available for viewing by the students in their own time, while teacher-led learning occasions become more focused toward explanation and discussions of theories. According to Goodwin & Miller (2013) the teacher is regarded as a coach that identifies ILOs and guides the student to higher level of learning. Flipped classroom has according to the research of Findlay-Thompson & Mombourquette (2013) both positive and negative sides. Using the Flipped classroom it is therefore crucial that everyone involved understands and cooperates with the purpose and that teacher can create engagement within the group and use the full concept, not just launching some videos. The flipped classroom approach can solve problems in case of pacing through enhancing self-paced learning that according to Hattie (2008) is one of the more important aspects of learning. The concept also focuses on student-teacher interaction by e.g. letting the teacher talk with the students instead of at them.

Irrespective of approach followed, we believe that mixed methods for learning is important when implementing CDIO into engineering education, primarily because it enhances learning of both knowledge, skills, and attitudes, which are central to the CDIO syllabus (Crawley et al, 2011). According to Lopez-Perez et al (2011), the mixture and combination of different methods for learning enhance motivation and creates a more positive attitude towards learning. Introduction of new kinds of subjects fits well into engineering education curricula and calls for varying methods of teaching that can stimulate student engagement and activity in the classroom.
METHOD

This paper is based on a frame of reference where various theories of mixed methods for learning are discussed in order to create better learning. Towards this context four types of teaching methods are described, based on the experience of the authors. Finally a model of crucial factors is developed.

RESULTS AND EXPERIENCES

In this paper we focus on four types of learning activities, namely:

- Sharp live cases
- Experiential learning exercises
- Flipped classroom
- Theory-based practical exercises

Below these activities and our experiences regarding them are described.

Flipped classroom

A flipped classroom approach requires access to an electronic platform, where students are served a “smorgasboard” of readings, films and downloadable exercises dedicated to the different subjects of the course. In courses such as a basic course in Industrial Economics there can be 240 students and using this concept facilitates flexibility and ways to customization for every student’s learning and their chance to become their best.

Before participating in a classroom activity students can engage in prior assignments such as watching “trailers”. This can create a common starting point that also decreases having the teacher reading out loud and instead being able to focus on problem solving together. This creates possibilities for more learning during lectures which become interactive where teacher and students create the learning together. Beehives are used to let all 240 students interact at the same time and moreover all lectures are also recorded. This creates possibilities for the student to learn after class through being able to repeat, relate, and reflect. It is also possible to give the students feedback by recording small films reflective over a certain case or problem.

Based on our experience we propose the following success factors regarding flipped classrooms:

- Careful plan based on three phases: before, during and after classroom activities.
- Crucial that everyone involved understands the purpose and concept of the three phases.
- A well-structured course website with instructions and material for preparation, e.g. structured following the different subjects treated in the course. Each subject is then structured in “before-the learning occasion-activities”, “during-the learning occasion-activities” and “after-the learning occasion-activities”.

Experiential learning exercises

Experiential learning is based on exercises where students experience some type of problem-solving, role-playing, or engage in some other type of “doing”. This type of learning
engages students and lets them be an active part of their own learning (NIU 2012). Through experiential learning knowledge can be internalized in a more long-lasting way and skills & abilities can be trained and reflected upon.

Topics such as physics and chemistry often offer experiential learning in a lab setting. During courses in organization, entrepreneurship and leadership experiential learning is less commonly used, but equally helpful if done in a structured way. We have successfully used various exercises in order to enhance our courses and integrate experiential learning (e.g. “the organization game”, “paint book factory”, “value creation forum”). These exercises present the students with a set of given resources, specified prerequisites and rules, as well as an assignment. The goal is to simulate different real-life situations and let the students experience for themselves the relevance of theories and models presented in a course. After an exercise the students are given time to reflect, discuss and share their thoughts on what happened and why. A session ends with a summary of important learning points led by the teacher/instructor.

Based on our experience we propose the following success factors in experiential learning:

- The exercise should correspond to students’ interests and has to clearly relate to other course content. This relation should be explicitly explained by the course leader.
- Every exercise should have a specific, narrow focus and a few selected learning points that it attempts to cover.
- The teacher/instructor needs to prepare a strategy for summing up students’ insights in a structured way, e.g. a “board plan” similar to those used in case-based teaching.

**Sharp live cases**

For Linköping University relations and collaborations with industry and other external organizations are highly desirable. This is expressed in the policy for how the master of science programs in engineering should be run, i.e. that the education given should be relevant to industry. One way to address this is through using live-cases in undergraduate courses. Through collaborating with idea-owners, the students are given a taste of the everyday life of entrepreneurs and idea owners. Lecturing is mixed with practical work, which results in a feasibility analysis for the new venture. The live-cases are commonly (1) applied research projects aiming at commercial products, (2) independent inventor ideas or (3) non-core development ideas from established firms. They are recruited from our business networks. All of the cases are in an early phase of development. In some cases a company has been registered, but the majority are on project level.

When the course is started, the students form groups of approximately 5 persons. After this the live-cases are briefly presented, and then distributed. Lectures and more practical and hands on workshops are given through the course in order to give tools for analysis. Here the lectures give the theoretically based tools, and the workshops give insights in how these tools could be used in practice. Throughout the course, the students interact with their case-owners and work on their analysis. They make presentations, where they get feedback. They also get coaching from teachers and business coaches. The fact that there is no “one and true answer” and that the idea owner struggles along with the students gives important insights into the early stage entrepreneurial process. The fact that there is a stakeholder also calls for engagement.
From a recent evaluation of an entrepreneurship course held in the autumn of 2013 we got the following feedback comments: “Live-cases are valuable”, “Live-cases are good, but it is a bit problematic since we work with the idea-owners’ babies”, “it’s useful to have something to apply the theories on” and “Nice that we were allowed to work with live-cases, it gives anchoring and makes you feel that you can contribute.” When ranked by the students on a scale from 1 (not at all valuable) to 5 (very valuable) the mean value was 4.4.

Based on our experience we propose the following success factors regarding live-cases:

- Choose ideas carefully and make sure to have a good foresight - the process to find suitable ideas may take long time
  - too abstract ideas, or ideas that reside in a too early stage of development are commonly complicated to work with.
  - make sure that the idea owner is willing to engage with the students. Declare which learning objectives are focused.
- Make sure that the students are aware of that the ideas are “sharp” and thereby treat them and their owners with respect. It is also important to declare that learning is the main objective.

**Theory-based practical exercises**

Lectures on topics such as entrepreneurship commonly provide students with theoretical tools for analysis. However, we have recognized that students often have problems in implementing theories practically in their work. To address this problem, we have added dedicated workshops, where crucial theoretical tools and frameworks have been transformed into exercise material.

As example could be mentioned the Osterwalder and Pigneur business model creation framework “Business model canvas”, the SRI-international business concept tool NABC - Needs-Approach-Benefits-Competition, the classical Ansoff Product/market matrix, the industry analysis tool “five force analysis” by Porter, etc. We have also created own tools such as a process for how to create and craft an elevator-pitch or a good presentation. The models are extracted and printed at canvases in A3 format, they are introduced by the teacher and then the students work with them, both in teacher-supported group workshops and on their own. Through lifting out frameworks and analysis models on canvas sheets, the students are able to better implement theoretical models in their work.

Based on our experience we propose the following success factors regarding theory-based practical exercises:

- Introduce the material when the workshop is started.
- Prepare written instructions so that students can work on their own.
- Put references to theory at the course website so that students both can prepare ahead of the workshop and access further readings after the classroom activity.

**ANALYSIS AND CONCLUDING DISCUSSION**

The aim of this paper was to describe four innovative learning activities: “Flipped classroom”, “Experiential learning exercises”, “Sharp live cases” and “Theory-based practical exercises”, and share how they are used and combined in our courses. We also aimed to discuss
students’ experiences and results and experiences reported in the literature relating to entrepreneurial-, experience-based-, flipped- and blended learning approaches. In the light of the theories presented in our frame of reference, we propose a model of crucial components for learning, see figure 1.

Figure 1. Crucial components for learning

According to Fayolle and Gailly, “the range of theoretical choices, objectives, publics, pedagogical methods and institutional context” (2008, p 569) is important to take into account. The above figure illustrates our analytical model. It is created through the inspiration of the theories of learning reviewed and described in the above section. The model consists of four components, who affects the learning situation. The first component comprises the

Stakeholders; i.e. all parties interesting in the learning situation, course or program. Here we take a wider perspectiva than e.g. Fayolle and Gailly (2008), that solely includes the audience in the model, and leave other type of stakeholders out. In our model, the parties are e.g. teachers/lecturers, students, society and industry/future employers. Questions worth asking are: Who creates the learning? Who learns? What are the learning objectives/goals of the different stakeholders? What resources in case of course budgets, teachers, skills and desires are present?

The second component is Pedagogics; e.g. the key learning objectives, the pedagogical methods that can be used, the inspiration-factor as suggested by McInnis et al (2012). The individualization factor put forward by several studies in general and Kolb (1984) in particular could be met through use of mixed methods, such as flipped classrooms, experiential learning and theory-based practical exercises. Questions worth asking in the pedagogical work are: How is the journey to reach the learning goals arranged? What methods can be used? What kind of preparation is needed by the stakeholders? The three phase model (see Figure 2) can be used when introducing new learning activities.

Figure 2. The three phases of learning: before, during and after classroom activities.

The third component is the utilization of Technology; e.g. the technology available and usable for the current learning situation. The utility/benefits created by technology for the all knowledge creating stakeholders are in this context an important factor. Access to technology, in case of an electronic platform - a course web is crucial for e.g. a flipped classroom approach.

The fourth component is the Context in which the learning takes place. Context is here defined as the physical and virtual classroom, where the learning is facilitated, the external environment towards which the theoretical as well as the practical learning is mirrored and corresponded. In a general learning context, and especially in a CDIO context, the relevance of the education for e.g. the industry are of importance. This commonly implies that not only theoretical knowledge, but also a practical understanding of how theories can be implemented is of importance. To obtain this, use of live-cases can add important perspectives.

To summarize, when creating CDIO-based courses we suggest that teachers incorporate the four components of our model; Stakeholders, pedagogics, technology and context. With these components as background, and within the frame of the resources available, a teaching plan can be developed. This teaching plan can then be divided into sub-plans such as e.g. case teaching plans for usage of cases or board plans for use of experience-based methods. The four learning activities described in this paper are all useful tools for enhancing learning in CDIO-based engineering education. However, they are more demanding, at least initially, for the involved teachers and instructors because they require careful preparation, as well as testing and adjusting to specific student groups.

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