Author(s): Täks, Marge; Tynjälä, Päivi; Toding, Martin; Kukemelk, Hasso; Venesaar, Urve

Title: Engineering Students' Experiences in Studying Entrepreneurship

Year: 2014

Version:

Please cite the original version:

Täks, M., Tynjälä, P., Toding, M., Kukemelk, H., & Venesaar, U. (2014). Engineering Students' Experiences in Studying Entrepreneurship. Journal of engineering education, 103(4), 573-598. https://doi.org/10.1002/jee.20056

editing-JEE-3107

running head: verso: Students’ Experiences in Studying Entrepreneurship
recto Täks, Tynjälä, Toding, Kukemelk, & Venesaar
files:
text
tables
figures
captions
appendixes
$$

Engineering Students’ Experiences in Studying Entrepreneurship

Marge Täks[a], Päivi Tynjälä[b], Martin Toding[c],
Hasso Kukemelk[a], and Urve Venesaar[c],

[a]University of Tartu, [b]University of Jyväskylä,
[c]Tallinn University of Technology

Abstract

Background Entrepreneurial learning, or the acquisition of entrepreneurial skills, in engineering at the college level has become an important topic. The labor market needs engineers who are prepared to adapt to changing market conditions and enhance innovations that offer new value to customers and society as a whole. An entrepreneurial mindset, knowledge, skills, and attitudes are closely related to innovation and creativity as enablers of entrepreneurial actions that are essential to prepare students for a successful professional life.

Purpose This study sought to examine how engineering students experience studying entrepreneurship in a course that is based on a socio-constructivist view of learning and the integrative pedagogy model.

Design/method The data were collected using semistructured group interviews (n = 48) and individual in-depth interviews (n =16). The study adopted a phenomenographic research approach.

Results As a result of the analyses, four qualitatively different categories of experiencing entrepreneurship as part of an engineering degree program were identified. Entrepreneurship studies were experienced by students as a first step to self-directed learning, a preparation for work life, a path to possible self-employment, a context for developing leadership and responsibility for group achievement.

Conclusion The four categories identified show that integrating entrepreneurship studies in an engineering degree program can be experienced in a variety of ways by students. Pedagogical implications are discussed.

Keyword Entrepreneurship education; phenomenographic approach; integrative pedagogy model

(1)Introduction

Entrepreneurship has gained attention in the field of engineering education (Duval-Couetel, Reed-Rhoads, & Haghighi, 2010; Einstein, 2010; Kreiwall & Mekemson, 2010). The new generation of engineers is expected to have deep knowledge in their field of study as well as various skills in problem solving, communication, networking, information technology, and teamwork. They are also expected to show creativity, resilience, determination and risk - taking to achieve goals while being able to spot opportunities (Gibb, 2002, 2010; Harvey & Green, 1993; Harvey, Burrows, & Green, 1993; Kyrö, 2005; Fayolle & Gailly, 2008; Tynjälä & Gijbels, 2012). It has been suggested that specifically geared toward entrepreneurship education or studying entrepreneurship in college could developed such skills (Seikkula-Leino, 2007; Täks & Kukemelk, 2011). Thus, entrepreneurship education is seen as a means to encourage future graduates – even those who are not studying to become entrepreneurs – to develop and internalize entrepreneurial mindsets and skills in order to experience "intrapreneurship" (Antoncic & Hisrich, 2003), that is, to become entrepreneurial individuals who think and work like entrepreneurs without being entrepreneurs per se (for different definitions of entrepreneurship, see Damon & Lerner, 2008, or Antoncic & Hisrich, 2003).

Regarding engineering education, expectations are set high. For example, the annual report of the European Society for Engineering Education (SEFI) (2011) emphasized the importance of developing mindsets toward creativity, innovativeness, and entrepreneurship in universities **(**see also European Commission, 2006; European Commission & Norwegian Government, 2006; Higher Education and Training Council, 2012; and UK Quality Assurance Agency (QAA), 2012 reports.)

In the United States, President Barack Obama has stated that it should be a national priority to improve science, technology, engineering and mathematics (STEM) education over the next decade (Obama, 2009). So, engineering educators have taken measures to develop effective pedagogies for improving learning, creating entrepreneurial mindsets, and helping students to meet today's labor market expectations (Litzinger, Lattuca, Hadgraft & Newstetter, 2011). In contrast, in Estonia, where the present study was conducted, the engineering teachers at higher education institutes (=college) have mainly followed

traditional teaching principles and methods. Even though recent initiatives to promote STEM education in Estonia have been encouraging, changes in teaching practices and efforts to integrate entrepreneurship and real-life issues in engineering studies have remained modest. In order to fill this gap, the Estonian Ministry of Education and Research and the Ministry of Economic Affairs and Communication have initiated several programs to promote entrepreneurship education within the education system, especially in noneconomic domains. Also, several start-up programs, competitions, and incubators have been launched to offer opportunities to students who are interested in becoming entrepreneurs but who are not provided this opportunity in their higher eduction studies.

Despite the numerous efforts to promote entrepreneurship education within engineering higher education, it is rather difficult to find research on the role of entrepreurship education and its impact as well as changes in attitude toward it (Duval-Couetel, Reed-Rhoads & Haghighi, 2012). Standish-Kuon and Rice (2002) claimed there is no clear understanding of what entrepreneurship education within the engineering context should entail and to what extent it should be integrated into engineering education, and they recommended filling this research gap in the future.

Also, there is an absence of comprehensive research on how students respond to and experience entrepreneurship education and new forms of pedagogy, especially in college-level engineering. Most of the studies on entreprenurship education have focused on elective courses or programs that highly motivated students participate in, and rarely on compulsory courses where students' motivation and intentions vary considerably. Thus, our present study was designed to fill these research gaps by closely examining engineering students' experiences in studying entrepreneurship as a compulsory course. Our research was guided by the following research question: How do engineering students experience studying entrepreneurship as part of their degree program?

The present study was conducted using a specific compulsory course in entrepreneurship. Teaching and learning activities in the course were designed to improve students' entrepreneurial mindset, to deepen their understanding of enterprise and entrepreneurship processes, and to develop the appropriate skills. An overview of the principles and methods used in planning and implementing the entrepreneurship course are described in the next section.

(2)Pedagogy for Entrepreneurship Education

The aims of entrepreneurship education are related to personal development through creating awareness of one's own abilities and to enhancing the learner's entrepreneurial mindset. Entrepreneurial mindset, in this context, represents the orientation toward entrepreneurial activities, learning to deal with uncertainty and change, and pursuing innovation (Fayolle & Gailly, 2008). Rae (2003) defines entrepreneurial learning as recognizing and creating opportunities; interacting socially; using imaginative technologies to create multiple forms of value; managing organizations; and acting on those opportunities in innovative and even opportunistic ways, moving between ideas and activities. He adds that entrepreneurial learning is transformative, social, imaginal, emotional, and experiential learning that applies in multiple contexts. Thus, the entrepreneurial learning described in our study does not aim at urging students to become actual entrepreneurs as such, but at encouraging individuals' internal development of an entrepreneurial mindset or intrapreneurship in addition to skills needed in one's working life. And along the way, such entrepreneurial studies may encourage some students to pursue a career as future entrepreneurs.

In line with these points, the course under investigation followed the social-constructivist view of learning, where learning is seen as a building process in which knowledge is actively constructed by individuals and social communities in the process of negotiating meanings (Biggs, 1996; Duffy, Lowyck & Jonassen, 1993; Tynjälä, 1999; Tynjälä, Pirhonen, Vartiainen & Helle, 2009). In particular, the following constructivist principles were followed in designing the learning environment for the course (Tynjälä, 1999; Tynjälä et al., 2009): activation and reflection of students' previous knowledge; use of metacognitive and self-regulative skills; negotiations, sharing of meanings, discussions, and collaborative learning; problem solving and construction of artifacts; situated learning in authentic or simulated learning environments; teacher as facilitator of learning; and assessment that fosters metacognitive skills.

The pedagogical design of the entrepreneurship course followed the integrative pedagogy model (Figure 1; Tynjälä, 2008; Heikkinen, Tynjälä, & Kiviniemi, 2011). The central principle of the model is that learning environments (such as courses and facilities) are designed so that all basic elements of expertise – theoretical or conceptual knowledge, practical or experiential knowledge and skills, self-regulation skills and self-awareness, as well as sociocultural knowledge – are present and integrated with each other. Ideally, this integration takes place in close collaboration between educators and experts or authorities in the real world of working life (Tynjälä, 2008). Each component and application of the model is illustrated and described in more detail below and in Figure 1 and Table 1.

Figure 1 HERE

Table 1 HERE

Conceptual theoretical knowledge is explicit, universal, and formal in nature. In other words, it contains concepts, theories, and other types of information that can be easily accessed in texts or presented by the teacher to bring about deeper understanding. In the case of the entrepreneurship course, theoretical knowledge included theories of entrepreneurship and entrepreneurial processes, idea and opportunity creation, and organizational and management theories (Byers, Dorf, & Nelson, 2011; Hirsrich, Peters, & Shepherd, 2010). This knowledge was provided by the teacher in the form of reading and writing tasks that started with or resulted from team activities, followed by student reflection.

Practical experiential knowledge, in turn, emerges from doing and experiencing rather than by reading or listening to lectures; thus, it often is intuitive, implicit, and tacit in nature. Tacit knowledge can be made explicit by conscious reflection in situations that require problem solving. In the course, practical knowledge was gained through practical exercises and real life challenges (constant problem solving) that simultaneously provided students with the sociocultural knowledge related to entrepreneurship.

Self-regulative knowledge appears as a result of reflection that is a prerequisite step to self-directed learning. Self-regulative knowledge was developed by the students by increasing self-awareness and using reflective learning tasks that stimulated them to reflect on their understandings and feelings throughout the entrepreneurial learning process. Aspects related to time management and achieving stated goals were also addressed during the course by establishing strict timelines and collaboratively agreed goals.

An important aspect related to self-regulation in entrepreneurial learning is resilience, which is complicated to teach (Shepherd, 2004; Duening, 2010), but that can be developed by using different techniques. In the entrepreneurship course, these techniques included self-evaluation, peer evaluation, analyzing one's own failures and reactions to these failures, problem-solving tasks, and studying real-world stories of entrepreneurs overcoming crises (Shepherd, 2004; Duening, 2010).

Opportunity recognition is another important aspect of self-regulation in entrepreneurship education (Korsgaard & Nergaard, 2010; Duening, 2010; Rae, 2003). In the course examined here, opportunity recognition was practiced through creative idea generation tasks in interdisciplinary interaction (networking, discussing ideas with people from different

knowledge areas), as well as through real examples from the life stories of inspiring entrepreneurs.

Sociocultural knowledge is embedded in social practices of local contexts and cultural elements such as rules, unwritten laws, technology, and norms of the workplace. Therefore, participation and experiencing real-world activities are necessary for gaining this form of knowledge (Morris, Kuratko, Schindehutte, & Spivak, 2012).

As mentioned above, the basic principle of integrative pedagogy is the idea that all these components of professional expertise – conceptual, experiential, self-regulative, and sociocultural knowledge – should be integrated with each other in authentic problem-solving situations (Tynjälä, 2008; Tynjälä & Gijbels, 2012; Heikkinen et al., 2011). This kind of knowledge processing involves a dynamic interplay between cognitive, affective, and physiological elements (Morris et al., 2012).

A variety of mediating tools and processes are needed for integrating different forms of knowledge. These are pedagogical tools that involve students in active knowledge construction, such as writing (analytic tasks, diaries, narratives) and other tasks (discussions, collaboration, projects, problem-based learning (PBL), role playing, business plan development, and giving presentations). In the entrepreneurship course, the mediating tools included learning tasks that simulated specific real-world events that were uncontrollable and unpredictable but offered insights into critical questions that can act as triggers to develop learners' ability to deal with uncertaitnties and ongoing decision making (Haynie, Shepherd, Mosakowski, & Early, 2010). One example was a role playing game in a board meeting simulation where decisions relating to product development had to be made in reaction to competitors' actions in the marketplace, followed by reflection and analysis of the theories involved. Another sample task was analyzing existing organizational forms of business against the team's business idea in order to make decisions about the suitable legal form for it. Appendix A lists in more detail the learning tasks that were used as mediating tools between different forms of knowledge. All mediating tools used during the course were integrated with different kinds of assessment tools, such as peer-evaluation or oral and written teacher feedback. The central mediating process in the integrative pedagogy model is problem solving, which was realized through action-based learning (Revans, 1980; Gibb, 2002). The mechanics in this process involve action, interaction, reaction, transformation, and explicit cocreation (Sarasvathy & Venkataraman, 2011). Ongoing experiencing (learning, adaption, self-discovery, or social interaction) is essential to understanding of the nature of

business creation (Sarasvathy, 2001; Shepherd, 2004) and has an important role to play in entrepreneurship education.

While performing the learning activities described above and in Appendix A, the students needed to practice what is called "integrative thinking" (Kallio, 2011). This form of thinking is postformal, relativistic, dialectic, and critical, and ideally leads to transformative learning (Mezirow, 1991, 2003, 2006) or conceptual change (Vosniadou, 2008). Integrative thinking enables a learner to consider different aspects of the whole and to synthesize information from different sources (Kallio, 2011). Integrative thinking may also connect cognitive and emotional aspects of knowledge in thinking, integrate objective and subjective information, and connect implicit and explicit knowing as well as theoretical and practical knowledge (Kallio, 2011). Furthermore, it is related to the concepts of creativity and creative thinking that are also important aspects of entrepreneurship education. Supportive tools for students' integrative thinking development are conscious reflection and evaluation (Kallio, 1998; Liitos, Kallio & Tynjälä, 2012). In the entrepreneurship course examined in our study, the students practiced integrative thinking in learning tasks that, for example, required them to identify different business ideas that needed to be tested, evaluated, and organized into a business plan. This process meant constantly analyzing and combining many elements and aspects, and evaluating and reevaluating one's own thoughts and actions in the light of feedback and newly acquired data (such as different theories or data from the marketplace). For example, teams reevaluated product or service ideas after talking about and presenting them to potential customers and conducting market research.

Integrating different forms of knowledge also requires the use of different forms of intelligence, that is, analytical, creative, and practical intelligence (Sternberg, 2003). Analytical intelligence is used in problem-solving situations where different elements and their relations have to be considered (analyzing, evaluating, comparing). Creative intelligence is used in situations where novel solutions and new, nonexisting perspectives are needed. Finally, practical intelligence is needed for everyday problem solving as well as in practical problem-solving situations. Sternberg (2003) has argued that schooling has traditionally, although in an unbalanced way, emphasized the development of analytic thinking, whereas the integrated use of all three forms of intelligence would lead to better achievement. In the entrepreneurship course use of the three forms of intelligence was promoted so that the students were given practical problems for which they needed to produce creative solutions with analytical judgments. An example was the preparation of financial statements or sales forecasts based on market evaluation or segmentation strategies.

Ideally, the learning process based on the model of integrative pedagogy results in the creation of new knowledge and the development of generic skills, such as problem solving and communication skills and greater self-awareness. This process, also referred to as "effectuation" (Sarasvathy, 2001), should lead students to an affective state of thought that not only helps in constructing new knowledge but also results in actions. In the entrepreneurship course, new knowledge and raised self-awareness related to the students' ability to see new aspects of their own capacities, and this new self-confidence inspired some of them to continue with further entrepreneurship studies in order to be better prepared for self-employment possibilities. Also, in terms of new knowledge and skills, students recognized having developed totally new perspectives – either in relation to their future career plans or regarding their engineering studies. Most concretely, new knowledge appeared in a tentative business portfolio (including business plan, treaty, and contracts) that students constructed as an end product of the course.

One of the main concerns of teachers who adopt the social-constructivist view of learning is the assessment of students' performance as well as its complexity and added workload. So, it has to be highlighted that not only the goals of learning and different teaching and learning activities but also the assessment of learning have to be aligned with the constructivist framework (on constructivist alignment, see Biggs, 1996). Thus, while using the social-constructivist approach and integrative pedagogy in this course, we implemented various formative assessment forms, such as self-assessment, peer evaluation, teachers' response, presentations, project tasks, final business plan, development of ideas, and work in progress.

In sum, by using the theoretical principles of the social-constructivist view of learning and the model of integrative pedagogy in the context of entrepreneurial learning, we aimed at assuring that the implemented learning environments would form a whole, and where a learner would be invited to participate as an active and equal partner in a dynamic learning process (Blenker, Korsgaard, Neergaard, & Thrane, 2011). This pedagocical approach meant that the teacher is a facilitator and colearner of the learning process. This approach was new for the engineering students in Estonia, and therefore examining students' experiences of novel way of studying is important.

(1)Methodology

(2)Study Design

The purpose of the present study was to examine how engineering students experience an entrepreneurship course implemented in the framework of a socio-constructivist view of learning and the integrative pedagogy model. For this purpose, we utilized the phenomenographic research approach, which qualitatively investigates different ways people experience or understand a particular phenomenon or an aspect of the world around them (Marton & Booth, 1997; Marton & Pong, 2005; Åkerlind, 2005, 2012). Thus, the present study phenomenographically investigated engineering students' ways of experiencing studying entrepreneurship.

The results of our phenomenographic study are presented in the form of descriptive categories (Marton & Booth, 1997; Paakkari, Tynjälä, & Kannas, 2011). According to Marton and Booth (1997), each category should describe something clear and distinct about the experienced phenomenon in question; the categories should stand in a clear and logical relationship to other categories (overlapping relationship between them are allowed); and a limited (parsimonious) number of categories should be used to capture the variation in data.

(2)Sample and Context

The study was carried out over a period of four months, examining a compulsory entrepreneurship course offered as part of a degee in engineering. The participants were fourth-year full-time engineering students from three disciplines (automotive engineering, technical design, and textile and resource management). The average age of the participants was 24.6 years. The majority of the participants joined the engineering program either after graduating from high school or, as was the case for a few, after one to two years of work experience.

The technical design degree program aimed to develop knowledge and skills that enable students to design and develop models for clothing, using the latest technological equipment and programs. Specializing in clothing technology requires the ability to handle production processes, production design, and management. The textile and resource management degree program was based mainly on issues related to production processes, as well as to purchasing and sales processes that support production. However, many of the subjects or modules featured in these two curricula were similar, thus those groups were joined into one large group for the entrepreneurship course. Finally, the automotive engineering degree program aimed to provide specific knowledge for working in the changing technological environment of the automotive industry, with specialization either in traffic control and maintenance or as a specialist car repair mechanic. All graduates would go on to acquire a higher engineering

certificate with 240 credits as a result of their four years of study. This entrepreneurship course, worth 6 credits, was compulsory for all engineering students.

The data were gathered in two parts. First, semistructured group interviews were conducted with 48 of the total of 54 students (89%) and video recorded. Six of the students were not able to come to the interview because of illness or work responsibilities (many final-year students work as interns in companies). The interviews were held separately with each group (two automotive engineering student groups, one resource management group of students in the field of clothing and textiles, and one technical design and technology of apparel student group). Second, after conducting the group interviews, it became clear that because of the large number of students in each group (17, 17, 6, and 8, respectively), the information that the students gave in groups was partially incomplete, and therefore we decided to conduct additional, individual in-depth interviews with 16 selected students. Since the purpose was to capture the largest variation possible, the selection was based on students' self-assessments and their final grades in the course (to make sure that the sample included students with different achievement goals and levels). Since the technical design students had left their internships by the time their individual in-depth interviews for our study took place, only textile and resource management and automotive engineering students were interviewed during the second round of our interviews.

(2)Data Gathering

The four group interviews (n = 48) were conducted and video recorded right after the students' completion of the course and took approximately 90 to 120 minutes each, whereas the individual interviews took approximately 40 minutes each and were conducted two to three months after course completion. The interview guidelines (Appendix B) for both data collection phases were prepared beforehand and discussed among the researchers in detail to ensure consistency and smooth flow. In the event that a deeper understanding of the issues would be needed, additional questions were asked, such as, "Could you explain that further?" or "Could you give an example?" All interviews were video or audio recorded and transcribed verbatim, and these transcripts were the focus of the analysis (Åkerlind, 2005, 2012). After the seventh in-depth interview, the first signs of saturation were observed by the interviewers, but interviews were continued (despite saturation was confirmed after the eleventh interview) to ensure an adequate sample size.

(2)Data Analysis

Analysis started with the group interviews. During the analysis, the points where additional data were needed were identified and the plan for individual in-depth interviews was designed. Data analysis continued after the in-depth interviews were conducted. In the next phase, the two datasets were combined, and the combined data were analyzed as a whole. During the analysis, the transcripts were read several times by all of the researchers and the findings of each researcher were then compared and discussed until a consensus was achieved regarding their classification into categories (see Marton & Booth, 1997; Åkerlind, 2005, 2012; Paakkari, Tynjälä, & Kannas, 2010).

It is important to notice that although the phenomenographic research is based on the analysis of individuals' experiences, the purpose is to create a description of experiences at a collective level. In other words, the result of the study is a categorical system that describes the variation of experiences in a certain group of people. Thus, in the present study, phenomenographic research techniques were used with the aim of revealing the various ways that engineering students experience entrepreneurship studies. No single interview can be seen in isolation from the rest of the data, since results are presented on the collective level and one transcript is unlikely to correspond precisely with the specific category (see Åkerlind, 2005, 2012; Green, 2005; Paakkari et al., 2010).

Another important point in phenomenographic research is that it is a strictly data-driven analytic method. That is, the categories that will be formed during the analysis are not based on any pre-existing theory; instead, they are discovered from the data by the researchers. In this respect, the analytic process resembles the grounded theory of Glaser and Strauss (2009). The main difference is that while grounded theory usually focuses directly on the nature of the phenomenon in question, the phenomenographic approach aims to describe individuals' conceptions or experiences of the phenomenon rather than the phenomenon itself. Marton (1986, 1995) calls this a second-order perspective of research. At the beginning of the analysis, our focus was on identifying and describing students' ways of experiencing an entrepreneurship course in general terms. In our analysis, we stopped treating students as individuals and the data were treated as a whole. Similar ideas expressed by student were sorted into preliminary categoryies and criterion attributes of each category were made explicit on the basis on their similarities and differences (Marton, 1986). In this phase, the categories were assigned provisional titles. Once the provisional categories were identified, we started the horizontal analysis, which focused in more detail on what are called "dimensions of variation" (Marton & Booth, 1997; Marton & Pang, 2003), i.e., the specific aspects that differentiate the categories. After identifying all of the apparent dimensions of

variation, we were able to finally name the categories. The categories and their dimensions of variation are presented in Table 2.

The process of analyzing the data was iterative and comparative and involved continuous sorting and resorting of the data (Åkerlind, 2005, 2012) in order to minimize the personal perspectives of the individual researchers and thus to ensure the reliability of the findings (Green, 2005; Paakkari et al., 2010, 2011). Altogether, the phenomenographic data analysis can be seen as a very rigorous and systematic way of doing qualitative research.

(1)Findings

(2)Categories of Student Entrepreneurship Experiences

As a result of the data analysis, four qualitatively different ways of students' experiencing entrepreneurship studies were identified (Table 2). Studying entrepreneurship was seen by the students as: (1) a first step to self-directed learning, (2) a preparation for work life, (3) a path to possible self-employment, and (4) a context for developing leadership and responsibility for team achievement.

The categories formed are nested and inclusive. This means that Categories 2 to 4 may include aspects of the previous categories but not vice versa (Marton & Booth, 1997; Paakkari et al., 2010). As described in the Methodology section, what differentiates these categories are so-called "dimensions of variation" (Table 2). That is, the differences between the categories can be described with these dimensions: purpose of learning, expectations of the course, emotions involved during the course, teamwork orientation, experienced learning outcomes, importance in the curriculum, and attitude toward entrepreneurship. The four categories and seven dimensions are explained below with student quotations for each category.

Table 2 HERE

Category 1: First step to self-directed learning

The students expressing this view found themselves in a new situation in the entrepreneurship course, where they were expected to develop independent and self-directed learning. Their own expectations, based on their previous learning experiences, were different at the beginning. They had a strong focus on learning facts and expected to be told the right

answers by the teacher, and were not prepared for active learning. As a consequence, they experienced mixed feelings with high levels of negative emotions. They felt confused and lost when they realized that instead of reproducing material as usual, they had to start seeking for the answers on their own. These reactions can be seen in some of the participants' comments in the individual interviews:

> More materials should be handed out by the teachers, like in other subjects. (Male, interview)

> Suddenly, we had to find some theory by ourselves, but we were not used to this. (Male, interview)

> I did not like this uncertainty.I prefer learning by the teacher giving examples. (Male, interview)

Despite the confusion, these respondents positively confessed having experienced raised self-awareness through self- and group reflection:

> I found the self-evaluation we did, something I had not done before, very useful. . . . It made me think about myself. (Male, interview)

In this category, students did not see themselves as contributors to teamwork, but as receivers of it. Referring to the experienced outcomes, they mainly mentioned gaining new knowledge, learning from the group, and raised self-awareness:

> I learned a lot from my team members, and the most interesting thing was when we could see the other teams' results and could compare our work with their's. (Male, interview)

> I learned a lot about myself during the group work. (Female, interview)

Even though the students' attitude toward the topic remained rather distant and entrepreneurship was not seen as a personal option for the future, they considered the

experience valuable nonetheless. Therefore, students saw entrepreneurship as a valuable addition to the engineering curriculum:

> I'm really not interested in this subject. I just want to do my job, but I did get some useful information from it. . . . Still, it could be done on a voluntary basis, but, on the other hand, it cannot hurt to know this stuff. (Male, interview)

As a consequence, some students concluded in regard to entrepreneurial learning:

> I am not interested in it, but it is useful to know. (Male, interview)

Category 2: Preparation for work life

Raised self-awareness, self-regulation, and reflection were much more evident in this category than in the previous one, even though the relationship to entrepreneurship remained reserved. The students valued knowledge gained through self-directed and group learning activities and reflection. They felt that the course had given them a deeper understanding of the issues dealt with. They had mixed feelings and emotions at first but started to experience self-directed learning favorably later on in the course, even though they acknowledged it was challenging. They clearly recognized the opportunities that new kinds of studies offered, and emphasized the learning of new skills:

> We had to do a lot of analyses and seeking for information. I sat for hours in front of the computer. Before, I didn't even realize how much information there is about this issue and that has to be processed so that it starts to make sense. (Male, interview)

> It was very interesting and positive that other students were also involved. . . . .We had to learn both independently and with the group. . . . This helped me to develop a lot of new skills. (Male, interview)

> We had to learn how to swim. But this made us work more independently. The theoretical reading that we usually do does not give us as much as seeking the information ourselves, selecting important parts from it, analyzing it, and putting

> it together in a way for others to be able to understand what we want to say. (Female, interview)

The students' interest shifted from knowledge toward understanding the upcoming issues and processes, and their own part in the "big picture." Students regarded teamwork as an opportunity for self-evaluation and reflection and a valued experience, despite some difficulties such as personal relationships and time management issues. Working as part of a team also offered students a safe and positive environment for taking the first steps in acquiring skills that they hesitated exercising before:

> I think that these skills – to express yourself, to present something, to perform in front of the others, and economic thinking – are very useful, even if it's only for personal gain. (Male, interview)

> It is one thing to discuss something within your team and something else entirely to present the outcome to others. It changes the way you look at things. (Male, interview)

Students mentioned some challenges and setbacks (e.g., negative emotions) during the whole process, but these were also referred to as learning points later on, that is, as a starting point for the next step. They considered starting up one's own company unrealistic, but saw the skills acquired in the course extremely useful due to their relatedness to real-world activities. Students recognized the experience as helping them to understand management issues, decision-making processes, and companies' functioning, and as contributing to a more tolerant view of their colleagues. Since this course helped students to form an overall picture of their studies over the past three years, they regarded it important to be included in the engineering curriculum:

> I think it is very good that we had this subject. It should be in all curricula, even when one does not start up a company but is just going to work. Because when you know how companies work and what needs to be done for them to work, this is important. And if some people think it's important to start their own company, then this knowledge has even more value. (Male, interview)

> It is necessary that I am able to “sell” myself. And this kind of business-like thinking, engineers need it –and the understanding of how companies function, the processes involved. [The course] gave an understanding of the opportunities that an engineering education offers. If engineers cannot sell their ideas, then what are they for? (Male, interview)

The general attitude toward entrepreneurship that was built up during the course reflected students’ increased understanding of how learning about entrepreneurship helps them to better prepare themselves for their future work life:

> I don’t want to become an entrepreneur, but I can use this knowledge and these attributes in my future work life. (Female, interview)

Category 3: A path to possible self-employment

While in Category 2 students’ emphasis was still on deepening their understanding of entrepreneurial processes and issues, in this category, the emphasis shifted to developing teamwork skills as a prerequisite to entrepreneurship. Therefore, observing and learning from as well as giving input to the group were valued experiences. Other new aspects the students valued in their entrepreneurial studies were collaborative learning and thinking, improved time management, and delegating tasks among group members:

> It has been the only course where we have had group work that has allowed us to develop group thinking –thinking together and considering others. Finally, even the laziest members became active, and, all in all, we achieved this sense of *our group*. (Female, interview)

> So, we learned a lot about teamwork, how to delegate, how to manage time, to control and deliver the vision of the company. (Female, interview)

Another distinction between Categories 2 and 3 was the readiness and motivation of students to continuously challenge oneself (preceded and followed mainly by positive feelings and emotions), with the possibility of becoming an entrepreneur. While in Category 2 the students aim was to be employed, in this category, the choice of being employed by someone else became the secondary option:

> Now that I have a clearer picture of how to start up a company, and of the whole process, it does not seem so scary anymore. So, maybe some day I will be ready to go for it. (Female, interview)

> It has changed my thinking, already during the group work and meetings, and when solving problems. . . . It made me think about starting my own company. And because I gained more confidence, I started to like this idea even more. I think I want to become an entrepreneur. (Female, interview)

The more challenging a task was, the more motivated the students became, and the data suggest that the reason for this was an overall positive atmosphere within the teams, complemented by an "our" feeling. Accordingly, students found the subject of entrepreneurship very important in the degree program and felt that it should be applied more widely:

> It suits all curricula: business, engineering, and so on. One needs basic knowledge of how to implement one's ideas. (Female, interview)

> This subject summarized all the things that we have learned over the past three years . . . and showed how everything is interconnected. And if I want, some day, I now also know how to start up a company. . . . I wish that we had more of it. (Female, interview)

Students' attitude toward entrepreneurship, followed by raised self-confidence, was the most positive in this category, and was expressed clearly in connection with future goals:

> I definitely want to explore this further and possibly start up my own business. (Female, interview)

Category 4: A context for developing leadership and responsibility for team achievement

The final category differed from the other three categories in how the students were taking responsibility for their actions and for other team members' results, and considering

the wider business environment, not only group- and company-level processes. Thus, expressing social responsibility was typical for students in this category, and the students' worldview seemed broader here than in the other categories. The students expressing these views acted as responsible team leaders with the aim to keep a positive team spirit and high level of performance. So, they considered taking responsibility for others' actions, rather than simply finishing tasks by a deadline important. Overall, they had positive emotions such as relief and happiness when tasks were completed successfully. Due to their deep understanding of entrepreneurial issues and former personal experiences in work life or extracurricular initiatives, these students had pragmatic and strong opinions about their role as a leader and as a member of society. Referring often to individual achievements, they also stood up for their team members and other groups' members when they felt it necessary:

> Some groups were having problems at different stages, and somehow they could not get their group work going. It was interesting to observe, and sometimes I wished to go and do something about it. (Male, interview)

> Last year, we had an interesting subject, like this one, and it was positive and rewarding and got me really interested in those economic and entrepreneurial issues. It should be seriously considered how to make learning processes more appealing for all students and in all of the subjects we have had throughout our higher education. Maybe then, students would be keener on learning and achieving higher goals. (Male, interview)

Regarding teamwork, the focus remained on the students' own role in helping the team to achieve shared goals, seeing issues through the eyes of "a leader":

> I managed to create this flow of motivation that was somehow connected to the competition between the groups; as such, we always tried to have slides that were better in content and to offer something interesting. So, every time we went there, we were "selling" our corporate concept, and it worked for the whole group. (Male, interview)

> You have to be the manager, a leader, in order to bring a company into the future; because if you start up a company, you are the one with the vision and only you

> know where you want to go with it, so you are the one who has to find the right people to work for your vision, to form a team. I think this is the learning point that I value the most from this course. (Male, interview)

Responses that belong to this category were often a reflection of analytic “inner talk” and a comparison between different aspects; thus, critical thinking appeared much stronger in this category than in others. Regarding teamwork, the task delegation differed from other categories as well; instead of long discussions and random talk as in previous groups, time was managed more efficiently and in a more structured manner:

> We had meetings where we first went over what everybody had done so far and checked if everybody had kept their promises. Then we agreed on the next steps. Everybody could ask questions if they had any, and tasks were divided so that everybody could go back to doing their part. (Male, interview)

Another difference was these students’ looking at entrepreneurial issues as being important to society, and considering the issues more critically than was the case in the previous category:

> Entrepreneurial issues are widely spoken of in society, so it was worth going deeper into that since we cannot get far without considering these aspects. (Male, interview)

> I do have a different understanding about the wider business environment as a consequence [of this course] and I have started to follow what is going on out there. One thing is sure . . ., one-man companies are not sustainable and this should be communicated. Having a motivated team to work on your ideas is much more rewarding and economically beneficial. (Male, interview)

All in all, in this category students well articulated understanding of the teaching methods of the course as well as awareness in learning and learning strategies, and they considered the integration of entrepreneurial learning into the whole curriculum necessary:

> Actually, this subject should be implemented more broadly into other subject areas as well. We only managed to get a fraction of it's potential, not all of the nuances. . . . And, to be honest, this was the only subject I worked for so hard and independently during my years of studies. (Male, interview)

> The current curriculum with the course in entrepreneurship provides very good preparation for becoming an engineer, especially for those who want to be leaders of a team or organization in the future or to establish their own company. We now have a theoretical and practical knowledge about what's going on, and what subordinates think. (Male, interview)

In this category students presented a pragmatic and broad understanding of the essence of entrepreneurship and entrepreneurial learning. They represented a mature and realistic view of entrepreneurship as being a possibility with respect to self-employment, but only after carefully considering all of the alternatives and having gained sufficient experience to feel ready to go for it:

> I am open to all possibilities. I just might need some more work experience before I try to start up my own company. (Male, interview)

(1)Discussion

This article has examined how engineering students experienced studying entrepreneurship as part of their degree program. The entrepreneuship course radically deviated from the traditional type of lecture-based pedagogy that the students were accustomed to. The learning activities, environment, and teaching principles of the course followed the principles of the socio-constructivist view of learning and examples of best practices in teaching presented by Alan Gibb (2002, 2010), Pittaway and Cope (2007), Löbler (2006), Smith, Collins, and Hannon (2006), and others. The activities were designed to expand students' entrepreneurial mindset, develop their skills, and deepen their understanding of entrepreneurial processes related to personal development through collaborative learning, as well as to raise the students' level of self-awareness (Fayolle and Gailly, 2008). The integrative pedagogy model (Tynjälä, 2008, Tynjälä & Gijbels, 2012) was applied as a principle for organizing learning. Thus, the core of students' activities involved integrating theoretical knowledge with

practical, self-regulative, and sociocultural knowledge of entrepreneurship by using reflection, teamwork, and other active learning methods.

The findings of this study are based on group and individual interviews that were analyzed using the phenomenographic research approach. As a result, four ways of experiencing studying entrepreneurship were found: a first step to self-directed learning, a preparation for work life, a path to possible self-employment, and a context for developing leadership and responsibility for group achievement.

The categories differed from each other in seven dimensions: purpose of learning, expectations of the course, emotions involved during the course, teamwork orientation, experienced learning outcomes, importance in the curriculum, and attitude toward entrepreneurship. The first four of these dimensions of variation seem to relate to pedagogical aspects, while the last three are more related to outcomes of the course. Pedagogical implications of these findings are discussed next.

(2)Pedagogical Implications

The main finding of our study is the fact that the active learning required in the entrepreneurship course was experienced in different ways by the engineering students. Therefore, it is important to take into account these differences when planning and implementing entrepreneurship education. From the very beginning, the students' expectations of entrepreneurship studies and the purpose of learning differed. In settings where students are accustomed to traditional teaching, the transformation to self-directed learning causes considerable difficulties and even frustration (represented by Category 1). Therefore, it is essential to increase student awareness of the importance and purpose of varied teaching methods and learning goals. Reflection, as well as strong peer and teacher support, can help students to cope with such uncertainties and new realities. The more self-aware and confident the students become, the more easily they adopt self-directed learning.That is, teachers should bear in mind that students with modest achievements need more guidance and support toward better self-awareness, reflection, and self-directed learning than do students who demonstrate a self-directed and deep approach to learning already at the beginning of their studies (Littunen, 2000; Utsch & Rauch, 2000). Since the results of this study illustrate Grow's (1991) model of student self-directed learning, our results could be used as a theoretical guideline for implementing self-directed learning in relevant courses. Furthermore, Baxter Magolda's (2004) concept of self-authorship and Dweck's (2006) idea of growth mindset are useful tools in this context (see also interesting overlaps with Collins,

2011). It might also be helpful to try to identify the students who belong to Category 4, and to involve these more advanced students in the learning process as facilitators to support the less-advanced students who belong to Categories 1 and 2, although it may be difficult to make such distinctions at the very beginning of the course.

Dealing with emotions proved to be pedagogically important as well. The strongest emotions and feelings that students experienced in specific stages of learning were identified in Categories 1 and 3. Especially at the beginning, negative (e.g. anxiety, stress, frustration) emotions dominated in Category 1, while in Category 3, positive (e.g. relief, happiness, joy) emotions even turned into idealistic conceptions of entrepreneurship. The findings indicate that students' emotions should be taken into account when planning teaching and considered as an object of their reflection and discussion (further on emotions in entrepenurship education in Arpiainen et al., 2013). Becoming aware of others' reflections may help students make their learning explicit (Green, 2005; Tynjälä, 2008). Helping students to develop ability to deal with and act in an uncertain situations (Sarasvathy, 2001) is an important aspect of entrepreneurial learning and crucial for developing self-efficacy (see Bandura, 1994) and even resilience (Shepherd, 2004).

As the entrepreneurship course involved a good amount of collaborative learning, it was not a surprise that the students' experiences differed in teamwork orientation; student roles varied from the passive recipient to the active participant and group leader. The strong variation in teamwork orientation suggests that teachers should address, identify, and reflect on students' roles in groups before or at the time of team formations to ensure appropriate and effective student roles and rules within the groups. We also recommend to remain cautious toward too strong (autocratic) group management to ensure a positive and constructive atmosphere in teams.

In our study, we did not focus on gender differences. Nonetheless, one interesting observation in our findings was that there might be differences between male and female students in that male students placed more emphasis on developing leadership skills (Category 4), while female students viewed entrepreneurship education more as a path to self-employment (Category 3). Another observation concerned students' self-evaluations, which had been conducted at at the beginning and end of the course. Male students were more self-confident than their female co-learners at the beginning of the course, while the female students were more unaware of their own personal strengths than were their male co-learners. Thus, gender issues are worth investigating in further studies on entrepreneurship education.

(2)Perceived Outcomes of Learning

The students' experience of entrepreneurship education differed not only in how they perceived the pedagogical solutions of the course, but also in their evaluation of the outcomes. As for experienced learning outcomes, all of the students reported that they acquired new knowledge and skills and developed their self-awareness. Reflection and raised self-awareness seemed to be necessary preconditions for moving toward self-directed learning. Some of the students (Categories 3 and 4) also emphasized raised self-confidence, the motivation to continue entrepreneurial studies, and even the development of their readiness for leadership positions. All in all, the outcome goals of the integrative pedagogy model with respect to the development of skills seemed to have achieved. Most students developed an entrepreneurial mindset although students' perceptions of the importance of entrepreneurship studies in the curriculum varied. While some students included arguments such as "It was very useful, but could be voluntary," other comments emphasized the importance of entrepreneursip as the course. Some students argued that entrepreneurial issues should be applied more widely and suggested integrating entrepreneurship education in the curriculum; they emphasized that students' understanding of entrepreneurship should be deeper by the end of their schooling.

Finally, engineering students' attitude toward entrepreneurship varied considerably. Most of them considered entrepreneurship studies useful for personal development and future working life in general, even if they did not see entrepreneurship per se as a professional option in their future. Some students saw clear self-employment possibilities as an entrepreneur or recognized self-employment as a future option, given the conditions that the timing is right and the right people are onboard who want to achieve the same goals.

In general, the students recognized that, in comparison to their other course work during their three years of study, the course in entrepreneurship required more study hours and demanded greater effort in learning. In Category 4, some students made this explicit in their reflections, and confessed that it was unfortunate they only realized the value of the entrepreneurship course at the final stages of their studies. In addition, they mentioned that listening to lectures, taking written tests, and learning facts by heart was not as motivating as solving authentic problems and learning-by-doing that prepares them to deal with real-life situations. These remarks identify problematic issues concerning teaching styles in engineering education in general, not only in entrepeneurship courses, and that should also be addressed in regard to core subjects. Hence, this study's findings support the implementation

of a social-constructivist view in teaching and learning in engineering education as well as across higher education.

(1)Conclusions

So far, the phenomenographic research approach has rarely been applied in studies on engineering education (for exceptions, see Franz, Ferreira, & Thambiratnam, 1997; Stamouli & Huggard, 2007; Kleiman, 2008; Zoltowski, Oakes & Cardella, 2012), or in studies on entrepreneurship (for an exception, see Kyrö, 2009). The present study has taken a phenomenographic approach to the analysis of the experiences in entrepreneurship education tailored to engineering students. The four categories identified show that students experience the integration of entrepreneurship education into the engineering degree program in various ways. Furthermore, the study identified the various dimensions that differ between the categories or different ways of experiencing entrepreneurship studies. These dimensions reveal pedagogically critical aspects for developing entrepreneurship education. Altogether, these results contribute to better understanding and reevaluation of teaching practices of engineering in a college-level context. It is the responsibility of educators to create the right conditions for a more effective and efficient learning environment (Fayolle & Gailly, 2008). On the basis of the findings of the present study we believe that for developing an entrepreneurial mindset, a socio-constructivist view and integrative pedagogy are very promising approaches.

(1)Acknowledgments

This research was supported as an European Social Fund project by the Estonian National Doctoral School of Educational Sciences.

(1)References

Åkerlind, G. (2005). Variation and commonality in phenomenographic research methods. *Higher Education & Development, 24*(4), 321–334. doi:10.1080/07294360500284672

Åkerlind, G. (2012). Variation and commonality in phenomenographic research methods. *Higher Education Research & Development, 31*(1), 115–127. doi:10.1080/07294360.2011.642845

Antoncic, B., & Hisrich, R. D. (2003). Clarifying the intrapreneurship concept. *Journal of Small Business and Enterprise Development*, *10*(1), 7–24. doi: 10.1108/14626000310461187

Arpiainen, R.-L., Lackéus, M., Täks, M., & Tynjälä, P. (2013). The sources and dynamics of emotions in entrepreneurship education. *Trames: Journal of the Humanities and Social Sciences*, *17*(4), 383–399. doi: 10.3176/tr.2013.4.02

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Eds.), *Encyclopedia of human behavior* (pp. 71–81). New York, NY: Academic Press. (Reprinted in H. Friedman [Ed.], *Encyclopedia of mental health*. San Diego, CA: Academic Press, 1998.

Baxter Magolda, M. B. (2004). Self-authorship as the common goal of 21st–century education. In M. Baxter Magolda & P. M. King (Eds.), *Learning partnerships—Theory and models of practice to educate for self-authorship* (pp. 1–35). Virginia, US: Stylus Publishing, LLC.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*, 347–364. doi: 10.1007/BF00138871

Blenker. P., Korsgaard, S., Neergaard, H., & Thrane, C. (2011). The questions we care about: Paradigms and progression in entrepreneurship education. *Industry & Higher Education*, *25*(6), 1–11. http://dx.doi.org/10.5367/ihe.2011.0065

Byers, T. H., Dorf, R. C., & Nelson, A. J. (2011). *Technology ventures: From idea to enterprise* (3rd ed.). New York, McGraw-Hill.

Collins, J. (2011). *Good to great. Why some companies make the leap and others don't*. New York, NY: HarperCollins.

Damon, W., & Lerner, R. M. (2008). *Entrepreneurship across the life span: A developmental analysis and review of key findings*. Kansas City, MO: Kauffman Foundation.

Duening, T. N. (2010). Five minds for the entrepreneurial future: Cognitive skills as the intellectual foundation for next generation entrepreneurship curricula. *Journal of Entrepreneurship*, *19*(11), 1–22. doi: 10.1177/097135570901900101

Duffy, T. M., Lowyck, J., & Jonassen, D. H. (Eds). (1993). *Designing environments for constructive learning*. NATO ASI Series. Series F: Computer and Systems Sciences, (105). Berlin: Springer.

Duval-Couetel, N., Reed-Rhoads, T., & Haghighi, S. (2012). Engineering students and entrepreneurship education: Involvement, attitudes and outcomes. *International Journal of Engineering Education*, *28*(2), 425-435.

Dweck, C. (2006). *Mindset: The new psychology of success*. New York, NY: Random House.

Eisenstein, E. (2010). Proceedings from IEEE: Engineering and entrepreneurship: Creating lasting value from engineering. *Transforming Engineering Education: Creating Interdisciplinary Skills for Complex Global Environments*, Dublin, 1-15. doi:10.1109/TEE.2010.5508952

European Commission (2006). Communication from the Commission to the Council, the European Parliament, the Committee of the Regions. (2005) Implementing the Community Lisbon Programme: *Fostering entrepreneurial mind-sets through education and learning Brussels*, 13.2.2006. COM (2006) 33 final Commission proposal for a Recommendation on Key Competences for Lifelong Learning COM (2005)548 final. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0033:FIN:EN:PDF

European Commission & Norwegian Government (2006). Oslo Agenda for entrepreneurship Education in Europe. *Entrepreneurship Education in Europe: Fostering Entrepreneurial Mindsets through Education and Learning.* Oslo, 26-27 October 2006. Retrieved from http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/education-training-entrepreneurship/policy-framework/2006-conference/index_en.htm

European Society for Engineering Education (SEFI) (2011). Annual report. Published by SEFI aisbl, Brussels, Spring 2012. Retrieved from http://www.sefi.be/wp-content/uploads/SEFI%20Report%202011-final.pdf, 11.11.2012.

Fayolle, A., & Gailly, B. (2008). From craft to science: Teaching models and learning processes in entrepreneurship education. *Journal of European Industry Training*, *32*(7), 569–593. doi: 10.1108/03090590810899838

Franz, J. M., Ferreira, L., & Thambiratnam, D. P. (1997) Using phenomenography to understand student learning in civil engineering. *International Journal of Engineering Education*, *13*(1), 21–9.

Gibb, A. (2002). In pursuit of a new “enterprise” and “entrepreneurship” paradigm for learning: Creative destruction, new values, new ways of doing things and new combinations of knowledge. *International Journal of Management Review*, *4*(3), 233–269. doi: 10.1111/1468-2370.00086

Gibb, A. (2010). Concept into practice: Meeting the challenge of development of entrepreneurship educators around an innovative paradigm. The case of the International Entrepreneurship Educators Programme (IEEP). *International Journal of Entrepreneurial Behaviour & Research*, *17*(2), 146–165. doi:10.1108/13552551111114914

Glaser, B., & Strauss, A. (2009). *The discovery of grounded theory. Strategies for qualitative research*. A Division of transaction Publishers, Rutgers–The State University, New Jersey.

Green, P. (2005). Spaces of influence: A Framework for analysis of an individual's contribution within communities of practice. *Higher Education Research & Development*, *24*(4), 293–307. doi:10.1080/07294360500284607

Grow, G. (1991). Teaching learners to be self-directed. *Adult Education Quarterly*, *41*(3), 125–149. doi: 10.1177/0001848191041003001

Harvey, L., Burrows, A., & Green, D. (1993). Someone who can make an impression: report of the QHE employers' survey of qualities of higher education graduates. In L Harvey (Eds.), *Quality assessment in higher education: Collected papers of the QHE Project.* QHE (Quality in Higher Education),Birmingham, UK. Retrieved from http://hdl.handle.net/10068/481416

Harvey, L., & Green, D. (1993). Defining quality. *Assessment and Evaluation in Higher Education*, *18*, 9–34. doi:10.1080/0260293930180102

Haynie, J. M., Shepherd, D.A., Mosakowski, E., & Early, P.C. (2010). A situated metacognitive model of the entrepreneurial mindset. *Journal of Business Venturing*, *23*(4), 482–496. http://dx.doi.org/10.1016/j.jbusvent.2008.10.001

Heikkinen, H.L.T., Tynjälä, P., & Kiviniemi, U. (2011). Integrative pedagogy in practicum. In M.Mattsson, T.V. Eilertsen, & D. Rorrison (Eds.). 2011. *A practicum turn in teacher education.* (pp. 91–112). Rotterdam: Sense. doi:10.1007/978-94-6091-711-0_5

Higher Education and Training Council (2012). Enterprise and Entrepreneurship Education (EEE). Draft Guidelines and Key Criteria for the Review of EEE. Retrieved from http://www.hetac.ie/docs/EEE%20Draft%20guidelines%20B-W%20for%20issue%20prior%20to%20conference.pdf , 25.06.2012.

Hisrich, R. D., Peters, M., P., & Shepherd, D. A. (2010). *Entrepreneurship* (8th ed.) Boston, McGraw-Hill.

Kallio, E. (1998). Training students' scientific reasoning skills. *Jyväskylä studies in education, psychology and social research,* vol. 139 (series). Retrieved from http://selene.lib.jyu.fi:8080/vaitos/studies/studeduc/ 9513912922.pdf

Kallio, E. (2011). Integrative thinking is the key: An evaluation of current research into the development of thinking in adults. *Theory and Psychology*, *21*(6), 781–801.

Kleiman, P. (2008). Towards transformation: Conceptions of creativity in higher education. *Innovations in Education and Teaching International*, *45*(3), 209–217. doi: 10.1177/0959354310388344

Kreiwall, T., & Mekemson, K. (2010). Instilling the entrepreneurial mindset into engineering undergraduates. *Journal of Engineering Entreprenurship, 1*(1), 5–19. Retrieved from http://rbb.union.edu/kern/Downloads/Documents/4_FINAL_Kriewall_Mekemson.pdf

Korsgaard, S., & Neergaard, H. (2010). Sites and enactments: A nominalist approach to opportunities. In W. Gartner (Ed.), *Entrepreneurial narrative theory ethnomethodology and reflexivity (*pp. 137–152). Clemson, SC: Clemson University Digital Press. Retrieved from http://www.virtual.clemson.edu/caah/cedp/cudp/pubs/enter/enter2010.pdf#page=142

Kyrö, P. (2005). Entrepreneurial learning in a cross-cultural context challenges previous learning paradigms. In P. Kyrö & C. Carrier (Eds.), *The dynamics of learning entrepreneurship in a cross-cultural university context* (pp.68–102). Entrepreneurship Education series 2/2005, Hämeenlinna, Finland: University of Tampere, Research Centre for Vocational Professional Education.

Kyrö, P. (2009). Gender lenses identify different waves and ways of understanding women in entrepreneurship. *Journal of Enterprising Culture*, *17*(4), 393–418. doi:10.1142/S021849580900045X

Liitos, H.-M., Kallio, E., & Tynjälä, P. (2012). Transformations toward mature thinking: Challenges for education and learning. In P. Tynjälä, M-L. Stenström, & M. Saarnivaara (Eds.), *Transitions and transformations in learning and education* (pp. 51–66). Dordrecht, The Netherlands: Springer. doi:10.1007/978-94-007-2312-2_4

Littunen, H. (2000). Entrepreneurship and the characteristics of the entrepreneurial personality. *International Journal of Entrepreneurial Behaviour & Research*, *6*(6), 295–309. doi:10.1108/13552550010362741

Litzinger, A. T., Lattuca, R. L., Hadgraft, R. G., & Newstetter W. C. (2011). Engineering education and the development of expertise. *Journal of Engineering Education*, *100*(1), 123–150. doi:10.1002/j.2168-9830.2011.tb00006.x

Löbler, H. (2006). Learning entrepreneurship from a constructivist perspective. *Technology Analysis & Strategic Management*, *18*(1), 19–38. doi:10.1080/09537320500520460

Marton, F. (1986). Phenomenography: A research approach to investigating different understandings of reality. *Journal of Thought*, *21*, 28–49.

Marton, F. (1995). Cognosco ergo sum: Reflections on reflections. *Nordisk Pedagogik*, *15*(3), 165–180.

Marton, F., & Booth, S. (1997). *Learning and awareness*. Mahwah, NJ: Lawrence Erlbaum.

Marton, F., & Pang, M.F. (2003). Faces of Variation: On continuity in the phenomenographic movement. *Scandinavian Journal of Educational Research, 47*(2), 145-156. doi:10.1080/00313830308612

Marton, F., & Pong, Y. W. (2005). On the unit of description in phenomenography. *Higher Education Research & Development*, *24*(4), 335–348. doi:10.1080/07294360500284706

Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco, CA: Jossey-Bass.

Mezirow, J. (2003). Transformative learning as discourse. *Journal of Transformative Education*, *1*(1), 58–63. doi:10.1177/1541344603252172

Mezirow, J. (2006). An overview of transformative learning. In P. Sutherland & J. Crowther (Eds.), *Lifelong learning: Concepts and contexts* (pp. 24–38). New York, NY: Routledge.

Morris, M., Kuratko, D. F., Schindehutte, M., & Spivak, J. A. (2012). Framing entrepreneurial experience. *Entrepreneurship Theory and Practice*, *36*(1), 11–40. doi:10.1111/j.1540-6520.2011.00471.x

Obama, B. (2009). *"Educate to Innovate"" Campaign for Excellence in Science, Technology, Engineering & Math (STEM) Education*. Washington, DC: The White House Office of the Press Secretary. Retrieved from http://www.whitehouse.gov/issues/education/k-12/educate-innovate , 09.08.2014

Paakkari, L., Tynjälä, P., & Kannas, L. (2010). Student teachers' ways of experiencing the objective of health education as a school subject: A phenomenographic study. *Teaching and Teacher Education*, *26*, 941–948. Retreived from http://dx.doi.org/10.1016/j.tate.2009.10.035

Paakkari, L., Tynjälä, P., & Kannas, L. (2011). Critical aspects of student teachers' conceptions of learning. *Learning and Instructions*, *21*(6), 705–714. Retrieved from http://dx.doi.org/10.1016/j.learninstruc.2011.03.003

Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. *International Small Business Journal*, *25*(5), 479–510. doi:10.1177/0266242607080656

Quality Assurance Agency for Higher Education (QAA) (2012). Enterprise and Entrepreneurship Education Guidance for UK Higher Education Providers. Draft for

consultation, February 2012. Retrieved from http://www.qaa.ac.uk/Publications/InformationAndGuidance/Documents/EE_Draft_Guidance.pdf , (n.d.) 03.11.2012.

Rae, D. (2003). Opportunity centred learning: an innovation in enterprise education? *Education + Training*, *45*(8), 542–549. doi:10.1108/00400910310508928

Revans, R. (1980). *Action learning: New techniques for management*. London: Blond / Briggs.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of Management Review*, *26*(2), 243–263. doi:10.5465/AMR.2001.4378020

Sarasvathy, S. D., & Venkataraman, S. (2011). Entrepreneurship as a method: Open questions for an entrepreneurial future. *Entrepreneurship Theory and Practice*, *35*(1), 113–135. doi:10.1111/j.1540-6520.2010.00425.x

Shepherd, A. D. (2004). Educating entrepreneurship students about emotion and learning from failure. *Academy of Management Learning and Education*, *3*(3), 274–287. doi:10.5465/AMLE.2004.14242217

Seikkula-Leino, J. (2007). *Opetussuunnitelmauudistus ja yrittäjyyskasvatuksen toteuttaminen.* Opetusministeriön julkaisuja 2007:28, Helsinki: Yliopistopaino.

Smith, A. J., Collins, L. A., & Hannon, P. D. (2006). Embedding new entrepreneurship programmes in UK higher education institutions. *Education + Training*, *48*(8/9), 555–567. doi:10.1108/00400910610710001

Stamouli, I., & Huggard, M. (2007). Phenomenography as a tool for understanding our students. *International Symposium for Engineering Education*, Dublin City University, Ireland. Retrieved from http://doras.dcu.ie/447/1/Stamouli-huggard_ISEE07.pdf

Standish-Kuon, T., & Rice, P. M. (2002). Introducing engineering and science students to entrepreneurship: Models and influential factors at six American universities. *Journal of Engineering Education*, *91*(1), 33–39. doi:10.1002/j.2168-9830.2002.tb00670.x

Sternberg, R.J. (2003). *Cognitive psychology* (3rd ed.) Belmont, CA: Wadsworth.

Täks, M., & Kukemelk, H. (2011). Implementing a problem solving approach to entrepreneurship studies in Estonia – Challenges and opportunities. *Educational Alternatives*, *9*(2), 245–258.

Tynjälä, P. (1999). Towards expert knowledge? A comparison between a constructivist and a traditional learning environment in the university. *International Journal of Educational*

Research 31(5), 355–442. Retrieved from http://dx.doi.org/10.1016/S0883-0355(99)00012-9

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, *3*, 130–154. Retreived from http://dx.doi.org/10.1016/j.edurev.2007.12.001

Tynjälä, P., & Gijbels, D. (2012). Changing world – Changing pedagogy. In P. Tynjälä, M-L. Stenström & M. Saarnivaara (Eds.) *Transitions and transformations in learning and education* (pp. 205–222). Dordrecht, the Netherlands: Springer.

Tynjälä, P., Pirhonen, M., Vartiainen. T., & Helle, L. (2009). Educating IT project managers through project-based learning: A working-life perspective. *Communications of the Association for Information Systems*, *24*, article 16.

Tynjälä, P., Slotte, V., Nieminen, J., Lonka, K., & Olkinuora, E. (2006). From university to working life: Graduates' workplace skills in practice. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life: Collaborations, confrontations and challenges* (pp. 73–88). Amsterdam, the Netherlands: Elsvier.

Utsch, A., & Rauch, A. (2000), Innovativeness and initiative as mediators between achievement orientation and venture performance. *European Journal of Work and Organizational Psychology*, *9*(1), 45–62. doi:10.1080/135943200398058

Vosniadou, S. (Eds.). (2008). *International handbook of research on conceptual change.* London: Routlege.

Zoltowski, C. B., Oakes, W. C., & Cardella, M. E. (2012). Students' ways of experiencing human-centered design. *Journal of Engineering Education*. *101*(1), 28–59. doi:10.1002/j.2168-9830.2012.tb00040.x

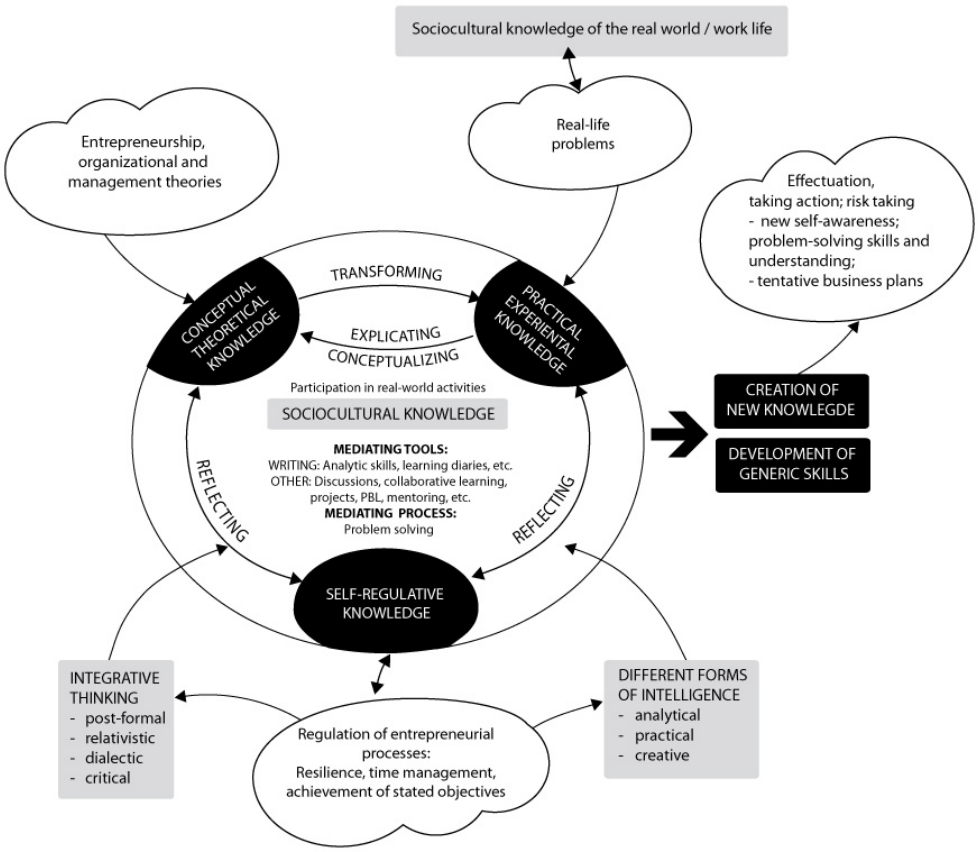

Figure 1 The modified integrative pedagogy model (Heikkinen, Tynjälä & Kiviniemi, 2011; Tynjälä et al., 2006; Tynjälä, 2008, Tynjälä & Gijbels, 2012) and its application in the entrepreneurship course for engineering students. (The components of the entrepreneurship course are presented in the cloud-shaped boxes.)

Table 1 The components of the integrative pedagogy model and their application in the entrepreneurship course

Component of the integrative pedagogy model	Description of the component	Application in the entrepreneurship course
Conceptual theoretical knowledge	Explicit, universal and formal in nature. Contains concepts, theories and other types of information that can be easily accessed in texts or presented by the teacher to bring about deeper understanding.	Entrepreneurship, organizational and management theories, idea and opportunity creation using: reading and writing tasks, analytic tasks beginning with team activites, followed by feedback and reflection.
Practical experiential knowledge	Emerges from doing and experiencing. Often intuitive, implicit and tacit in nature. Can be explicated by conscious reflection in situations that require problem solving.	Preparation for real-life problems: using practical excercises, interaction with one's team and the real world, and subsequent feedback and reflection.
Self-regulative knowledge	Develops as a result of reflection that is a prerequisite step to self-directed learning. Involves regulation of entrepreneurial processes.	Reflection upon one's own activities. Resilience, time management, self-evaluation and peer evaluation, analyzing failures and real-world stories, recognizing opportunities, engaging in interdisciplinary interaction, and setting goals in relation to the given time and tasks.
Sociocultural knowledge	Embedded in social practices of local contexts and cultural elements such as rules, unwritten laws, technology, and norms of the workplace.	Simulations of real-life situations and problems: using role play, analytic tasks, and tasks that allow interplay between cognitive, affective and psychological elements.
Mediating tools	Needed for integrating different forms of knowledge. Involve students active knowledge construction as well as evaluation of accomplished tasks.	Analytic tasks, diaries, narratives, discussions, collaboration, projects, problem-based learning (PBL), role play, business plan development, giving presentations, different assesement tools such as teacher feedback (written, verbal), peer evaluation, project tasks.
Mediating processes	Problem solving, realized through active learning.	Action, interaction, explicit co-creating, gaining experience while working to achieve set goals.
Integrative thinking	Form of thinking that is post-formal, relativistic, dialectic and critical (synthesizing information, connecting implicit and explicit knowing), and ideally leading to transformative learning or conceptual change.	Conscious reflection and evaluation, identification and interactively evaluating business ideas and organizing these into a business plan. This process requires analyzing, combining, evaluating and re-evaluating thoughts and actions in the light of feedback and theories.
Different forms of intelligence	Analytical (analyzing, evaluating, comparing), creative (novel solutions) and practical (practical problem-solving situations) intelligence.	Practical problem-solving tasks in which students need to produce novel solutions and justify their choices using theories and/or analytics (e.g., forecasts, cash flow accounting).
Creation of new knowledge and generic skills	Examples of these skills are problem-solving, communication, IT and other skills, as well as taking action (being proactive).	Rasising self-awareness and confidence through self-evaluation and constant reflection throughout the learning process (involving personal skills and task-related reflection).

Table 2 Categories and Dimensions of Engineering Students' Ways of Experiencing Studying Entrepreneurship as Part of Their Study Program

	CATEGORIES			
DIMENSIONS OF VARIATION	**1. A first step to self-directed learning**	**2. A preparation for work life**	**3. A path to possible self-employment**	**4. A context for developing leadership and responsibility for team achievement**
Purpose	To develop self-directed learning	To develop self-regulation, skills and knowledge for future work life	To develop team-working skills and prerequisites for entrepreurship	To develop oneself
Expectations	Right answers, guidance, group support	Deeper understanding	Enhanced skills	Enhanced skills and getting confirmation via group achievement
Emotions involved	Negative high	Negative ↓↑ positive	Positive high	Positive
Teamwork orientation	Group ↓ Student	Student ↓↑ Group	"Our team"	"My team"
Experienced outcomes	New knowledge and skills, better self-awareness	New knowledge and skills, overcoming the challenges	New knowledge and skills, confidence and motivation to continue learning	New knowledge, confidence in and development of leadership skills
Importance in the curriculum	"Could be useful and supports personal development"	"Must be useful for personal development and prepares one for future work life"	"Should be applied more widely"	"Should be integrated"
Attitude toward entrepreneurship	Not a personal option	Not a personal option	Self-employment as an entrepreneur is a possible personal option	A possible personal option after gaining some work experience