ENABLING DEVELOPMENT OF INNOVATION COMPETENCES BY MULTIDISCIPLINARY LEARNING ENVIRONMENTS

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Abstract

All sectors of the economy emphasise the importance of innovations. Businesses and organizations are continuously looking for innovative employees. Consequently, how to educate innovative graduates is a crucial question for educators. The aim of this paper is to discuss how to develop students’ innovation competences by applying a multidisciplinary learning environment. In this paper, we first describe a learning approach called innovation pedagogy, which aims to educate innovative graduates. In order to participate in innovative activities in working life, it requires that graduates must have not only the study field specific competences but also the innovation competences. This paper also presents the results of the research done on defining innovation competences, which are a prerequisite for innovative knowledge. Based on the research results innovation competences can be presented in form of five dimension: critical thinking, creativity, initiative, teamwork and networking. Each of these dimensions is measured via items which together form the final score of a person. After describing innovation pedagogy and defining innovation competences, we present one example of how to build an innovative multidisciplinary environment in higher education where both approaches are present. The presented example gives ideas how to develop students’ innovation competences through social learning in a diverse surrounding. However, the implementation of a multidisciplinary approach and training students’ innovation competences has many challenges and it can meet strong opposition especially by the faculty members but also by the students. In our paper, we discuss how we handled the implementation and present our view on the results to which it has led to.

Keywords: Innovation pedagogy, competence, learning outcome, multidisciplinary learning

Introduction

Innovations are a topic handled all over in modern society. When aiming to create added value the companies are increasingly basing their earnings logic on innovations. There are several definitions on innovation and the topic itself is constantly evolving. Today we understand something different by innovation than some five years ago. In ISPIM 2018 Innovation conference the innovation was defined simply as something novel and valuable. Verganti (2016) makes a notion that today we are more facing the problem of defining a meaningful direction when considering innovation rather than being worried about the amount of ideas when looking for solutions to problems which are difficult to solve in the field of a single discipline. It is known that new solutions based on innovations are best born at the boundaries of different knowledge domains. (Kairisto-Mertanen & Mertanen, 2007; Kairisto-Mertanen et al., 2010; 2011; Konst 2017.)

World is changing at a speed never seen before. The companies and other working life organizations are facing the need to adapt themselves to the changing customer requirements, to the changing ways of conducting work and to the changing conditions in the whole environment. All this calls for capability to change old ways of doing things. The universities are supposed to educate the future labour force. They should be at the top of the development and capable of meeting new requirements. However, at universities, we still tend to educate students with traditional methods meant originally for a stable world, emphasizing the learning of explicit knowledge.

The aim of this paper is to discuss how to develop student’s innovation competences by applying multidisciplinary learning environments. We also give one concrete example of innovative learning method where innovation competences have been set as learning outcomes for first year engineer students. The paper does not only focuses to present the method and connect it to the development of student’s innovation competences, but also to reflect our experiences as educators concerning implementing a new and innovative learning method in the faculty.
Methods better suited for a constantly changing world focus on activating students in learning and include unofficial and exceptional situations. It is a crucial step for any nation to be able to educate future generations so that they are equipped with the tools and understanding needed in the present and future world. It is also a crucial step for any university to be able to adapt their studies to these needs and continue to develop new approaches to meet them. (Kairisto-Mertanen, 2017.)

Innovation pedagogy is the new learning approach with an aim to educate graduates who in addition to the study field specific competences also gain competences called innovation competences, which help them to be active in different innovation processes and ultimately create innovations (Kairisto-Mertanen et al., 2012; Kettunen et al., 2013). The innovation competences include the 21st century skills defined by OECD but they have been defined so that also the innovation aspect has been taken into account.

It is important to understand what we mean by innovation as it can be defined in many ways. According to Rogers (2003) it is an idea, practice or object that is considered new. In innovation pedagogy, we use the definition of Finland’s national innovation strategy (Innovation Strategy 2008), where an innovation is understood as a competitive advantage based on knowledge. According to this definition, innovation can also be understood as a process that can be already existing but new in the circumstances where it is being applied (Lehto et al., 2011; Kairisto-Mertanen et al., 2010).

To make sure that the defined aims will be met we have defined several cornerstones, which should be present in the learning environment. Some of these cornerstones such as multidisciplinary education or RDI activations embedded in learning, require a strategic decision made by the university but some of them, such as activating learning and teaching methods or versatile and development-oriented assessment, can be made at the faculty level or even at the individual teacher level. The different cornerstones are presented in figure 1.

![Figure 1. The outcomes, competences and cornerstones of innovation pedagogy (Keinänen & Kairisto-Mertanen, 2018; Kairisto-Mertanen 2017.)](image)

The cornerstones are essential requirements for the everyday application of innovation pedagogy. They are designed to guarantee that the desired learning outcomes will be produced during the learning process as they are enabled in the learning environments.

There are altogether nine cornerstones which are: multidisciplinarity, working life orientation, integration between studies and RDI activities, versatile and development-oriented assessment, activating learning and teaching methods, flexible curricula, entrepreneurship, internationalization, and renewing teacher roles.

The innovation process calls for different types of knowledge to be available and to be used. This requires that the learning environments also are multidisciplinary. Working life orientation and integration between studies and RDI activities are needed to ensure that learning takes place in authentic learning environments where real-life situations are brought to be handled in the learning situations in format of assignments and projects stemming from the working life. This way it becomes possible to emphasize that the task of education is also to develop, renew and question the models of operation in working life. People with different talents and competences interact in the learning environment which in addition to a physical space is also a virtual and social space.

The learning and teaching methods have been shown to be the most important cornerstone regarding the development of student’s innovation competences (Keinänen & Kairisto-Mertanen, 2018). Their aim is to activate the students in actively constructing knowledge and meaning from the situations they meet. One of the key elements is also the flexibility of the curriculum, which enables students to take various alternative learning paths. It means that the curriculum can be adapted during the study years to meet the needs and motivation of each individual learner. Adopting entrepreneurial attitude is needed in working life regardless of the tasks or study field. It includes also the ability to manage innovations and have the courage to seize the opportunity in the situations encountered. The world is becoming increasingly global and new graduates are facing the situation of a multicultural working environment instantly when entering working life. This requires that the students develop both their language skills and cultural understanding needed when entering working life and encountering the global working environment. Teachers and faculty members in general are the key people to make the innovation pedagogy approach work so they have to be ready and willing to constantly reflect and question their ways of conducting teaching.

**Innovation competences as objects for learning**

In innovation pedagogy, innovation competences are the targeted learning outcomes. Learning outcomes are statements used to describe what a learner is expected to know, understand and do at the end of a period of learning. These statements describe what is achieved and assessed at the end of the course. Guidelines for learning outcomes highlight that they should be clearly observable and measurable (Buss, 2008; Harden, 2002). Competence is a holistic concept, which describes a
person’s ability to manage in a specific context (Mulder, 2012). According to Marin-Garcia, Pérez-Penalver and Watts (2013), competences, capacities and skills can be considered the three categories of complexity in contextualized know-how. A competence is formed by a set of capacities and these, in turn, are formed by several skills, all of which are required for a more complex professional performance.

The work of defining innovation competences and creating a tool to assess them has been done in several EU funded projects in a network of universities (e.g., Keinänen, Ursin & Nissinen, 2018). The results presented here are a result of a project called FINCODA (Framework For Innovation Competencies Development And Assessment), which was finished at the end of year 2017. The project partners included a significant number of universities and innovation-intensive companies from five countries, which were working together to develop a tool to measure innovation competences (Butter & van Beest, 2017; Marin-Garcia et al., 2016; Perez-Penalver et al., 2018).

The FINCODA Model of Innovation Competence, presented in Figure 2, is based on five equally important dimensions: Creativity, Critical Thinking, Initiative, Teamwork and Networking. Definitions of the five dimensions are:

- Creativity: ability to think beyond existing ideas, rules, patterns or relationships. To generate or adapt meaningful alternatives, ideas, products, methods or services regardless of possible practicality and future added value.
- Critical thinking: ability to analyse and evaluate advantages and disadvantages and estimate the risks involved for a purpose.
- Initiative: ability to influence/make decisions that foster positive changes. To influence creative people and those who have to implement the ideas.
- Teamwork: ability to work effectively with others in a group.
- Networking: ability to involve external/inside stakeholders outside the team. (Marin-Garcia et al., 2016; Perez-Penalver et al., 2018.)

If we want that students will learn innovation competences already during their studies, we must also embed these competence objectives in curriculum and take them into account in course designing. Consequently, we can develop learning environments, which mirror and simulate innovation processes.

Several studies also support these objectives. For example, Kivunja (2014) states that the key to teaching creativity and innovation skills lies in designing quality learning environments in which learners can solve real-life problems, and be inquisitive and open-minded. Instead, Vila et al. (2012) show that working together on solutions to new problems supports the acquisition of innovation capabilities in higher education students. Moreover, Keinänen and Butter (2018) and Keinänen and Oksanen (2017) have found that specific pedagogical practices in university-company cooperation develop students’ learning of innovation competences. Furthermore, it has been shown that an innovative curriculum improves students’ innovative performance (Hu et al., 2016).

Embedding a multidisciplinary approach and innovation competences in engineering education

The learning method described in this paper is called project hatchery. It is one of the methods developed at Turku University of Applied Sciences to be used with first year students when introducing them to the new way of learning according to innovation pedagogy and its cornerstones. During the project hatchery study unit new students start developing their innovation competences, such as creativity, critical thinking, initiative, teamwork and networking competences, and acquire a new way of learning and engaging themselves.

Project hatchery is based on real-life assignments, peer counseling and working in cross disciplinary groups. There have been many implementations during the past 10 years through which we have gained experience of delivering it to first year students and this way engaging altogether 500 students in this novel way of working. It is a 5 credit study unit and lasts for one semester. The working groups, consisting of 12-15 students, are formed to include as many different students from different study programs as possible. Each of the groups has a second year student tutor responsible for helping the students to proceed with their work when starting with this totally novel approach of learning.

The assignments for the hatcheries are versatile, some of them include tasks given by external stakeholders like companies and other organizations, some of them are topics stemming from internal research and development projects in the university. This study unit offered to all first-year students is also the first experience with the intensive activating teaching and learning methods applied in the faculty. Interacting in team work with students having totally different approach and
networking with the world are basics of the learning environment.

The main objective of this study unit is to make students understand that in addition to their own study field competences their future employers will require that they during their studies have developed and adopted more general competences as well the innovation competences. Innovation competences are expected in all fields in businesses and organizations.

This study unit introduces a new way of learning and working when new students start their studies and by activating the students also encourage them to take responsibility of their learning. In the hatcheries the students are expected to start creating new ideas as they work with people who might have different agendas and ways of thinking. (Kairisto-Mertanen, 2017). They are expected to learn how to define the goals of work and ways how to reach the goals. One of the student tutor’s tasks is to lower the anxiety among project hatchery students when they face the challenge of not knowing exactly what they expected to do. The students are also expected to learn how to continue after something which could not be described as a success. During their first study semester they are allowed to make mistakes but they are expected to learn from them.

The work in the project hatchery groups starts by helping the students to identify themselves as members of the team. It continues by helping the team to assign roles to each team member. The group has to select the project leader, the secretary and assign other roles to the rest of the team members. The project hatchery group is also expected to elaborate on the assignment and find their own angle from which they want to approach the task. When doing this they start developing a capability to take responsibility for whatever they are doing. We also want them to develop an intrinsic approach and motivation to their work.

Studies in project hatchery are designed to contain weekly hours of contact work but also independent work which, as well as the working methods, the groups are free to choose. The study unit also contains a few compulsory tasks allocated to each group involved. Every group has to: 1) draw a project plan for their work, 2) design and prepare a poster reflecting what they are doing, 3) make a presentation and present their work in a creative way, and finally 4) write a final report on their activities and results. Moreover, every student has individual learning tasks, where s/he has to reflect own learning, experiences, goals and motivation.

Because ultimately the learning goals of the project hatchery are not connected with learning of the study field specific competences which are different for most participating students but to learn innovation competences which are equal regardless of the study field, it is very important to define and discuss the goals together with the participating students. Once they are set together it is equally important to reflect reached results constantly in order to make learning visible.

The project hatchery as an innovative learning environment supports students not only in helping them create and meet goals on the development of their innovation competences, but also helping them to find their preferred role in the continuously changing innovation teams present in today’s highly volatile organizations. Innovation requires not only creatives, but also critics, initiators, co-operators and networkers.

Challenges and possibilities in multidisciplinary learning environments

Although the project hatchery is a functional pedagogical practice nowadays, it has required lot of long-term and persistent development work. In this section we shortly reflect our experiences and observations related to changing pedagogical practices towards innovative learning. We also highlight some main elements, which are needed to make a change, and point out some key findings, which have changed in faculty during the development period.

There are many challenges when introducing a new way of learning in the faculty. According to our experience it is especially challenging when students from many different study programs are put together for the first time. However, since project hatcheries started, a clear difference could be observed in the atmosphere of the faculty. Students from different study programs started to hang around and work together when they were not forced to doing so. In addition, based on feedback, interviews and discussions with students, it seems that project hatchery concept has a significant role increasing communality of students in the faculty. Perhaps, a shared and common learning experience with new fellow-students in discomfort zone is a key factor enhancing a sense of solidarity.

On the other hand, it is not just the students who have not been accustomed to studying together but also the faculty members who might be suspicious about the importance of different domains than their own. Developing trust seems to be a crucial question. Trust is needed when putting students working together across study programs but it is also needed between faculty members from different disciplines. The teaching profession has traditionally been very independent. After shutting the classroom door each teacher has had the freedom of delivering the content in his/her preferred way and even choosing the content to be delivered. Often the own content is considered to include the most important information to be learnt by the students. To accept that there a many different contents equally important requires understanding and trust on the colleague’s professional competence.

Building trust calls for getting to know each other. The role of the management is to organize occasions where faculty members can meet and get to know each other. Trust is not likely to develop without personal contacts and this is why many discussions are needed and space for them organized. It also possible to organize work supervision, which provides the chance to stand apart from one’s work and to reflect on what is being done, the context and the impact that this has on ourselves as professional people. Work supervision aims at learning through interaction. It is a relationship which is ethical and confidential and where both parties have
rights and responsibilities. Work supervision is also a forum for reflection and learning from our experiences. It can lead to professional growth. (Beddoe, 2010.) In project hatcheries, using work supervision was implemented a few years ago. Counselling sessions are not only used with teachers but also with student tutors. Its implementation has led to remarkable results. Counselling sessions have increased trust, communality and cooperation between teachers and students. For many teachers sessions have been an empowering experience and increased well-being at work. With this model, student tutors have also learnt a new reflecting and conversational method to develop their professional competences which later might be utilized in their future occupations or workplaces.

**Conclusions**

Higher education institutions have a crucial role in training innovative professionals for their future occupations. This requires that students have developed innovation competences and acquired needed experience already during their studies. To succeed in this requires new kind of learning environments. The aim of this article was to present one example of pedagogical practice of innovative learning environment in engineering education.

Innovation development requires risk taking, novel methods and ways to act and think, enthusiastic people, and supportive environments (Assink, 2006). The same elements should be required in education as well. Flexibility and learning to learn are the main success factors in future work according to OECD. Education must prepare students to meet the world where they continuously need to adapt to new ways of working, technologies and business models. However, success in working life is not the only aim for education. Successful education provides also happier individuals and functional societies, improves economic and sustainable development, and adds well-being and equality. This is both a challenge and opportunity for education; we can react, adapt, and have an active influence on the desired future. Competences provided by education are an important tool in shaping the future. The world keeps on changing, but we can have impact on that what kind of world we will have.

**References**


